Government Office for Science

Foresight

Powering our Lives:
Sustainable Energy Management and the Built Environment

FUTURES REPORT

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This report has been commissioned as part of the UK Government's Foresight Project: Powering Our Lives: Sustainable Energy Management and the Built Environment. The views expressed do not represent the policy of the UK Government.

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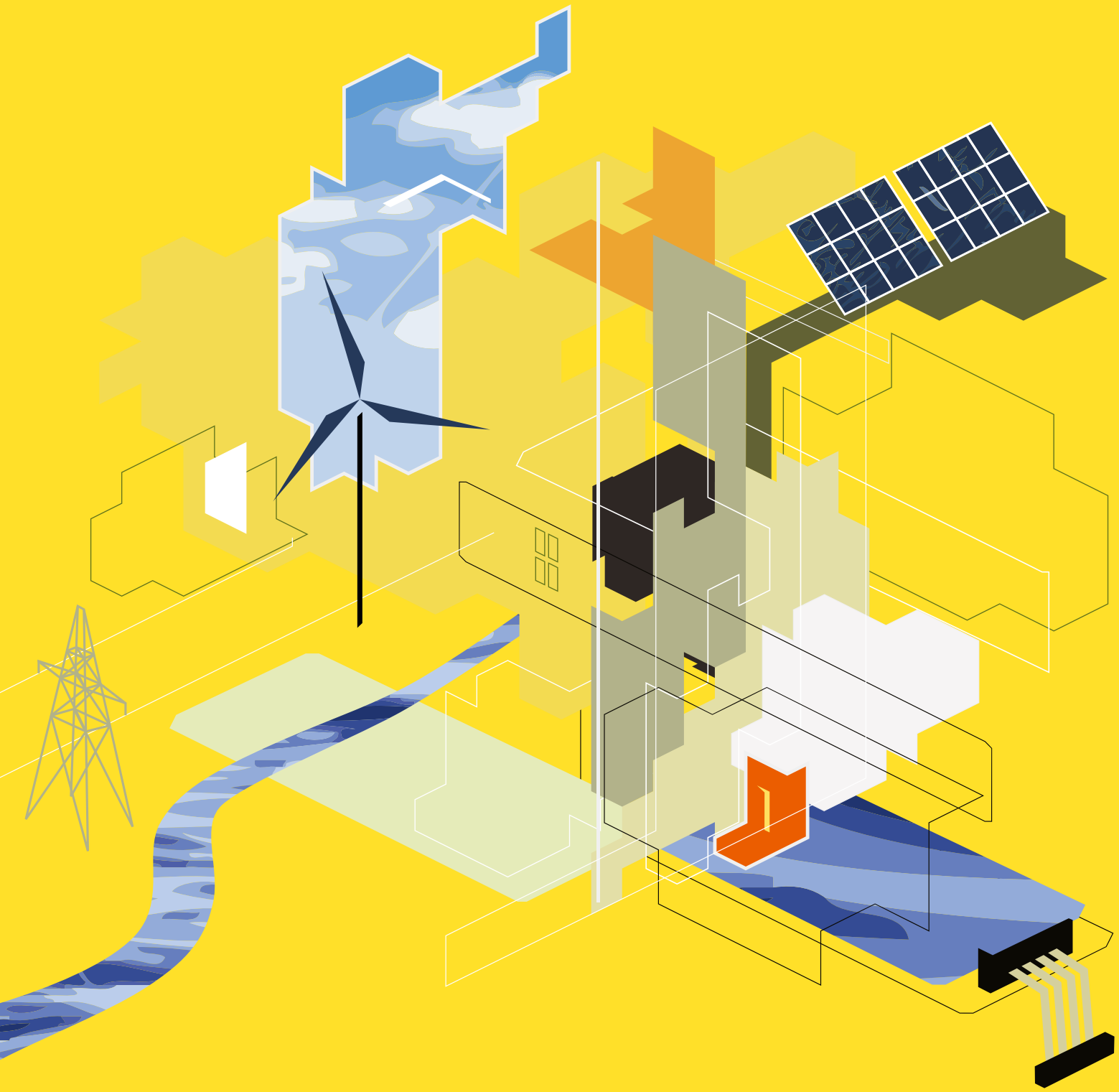

1 Introduction

1.0 Project outline

The role of Foresight is to strengthen strategic policy making by embedding a futures approach across government. It analyses complex issues that cut across government departments, combining robust science with well-informed futures thinking, to inform policy development in government and elsewhere. The *Powering our Lives: Sustainable Energy Management and the Built Environment* project aims to explore how the UK built environment could evolve to help manage the transition over the next five decades to secure, sustainable, low carbon energy systems that meet the needs of society, the requirements of the economy, and the expectation of individuals. As part of this project, four scenarios were developed around the future of sustainable energy management and the built environment, outlining some major areas of future uncertainty as well as potential future challenges and opportunities.

1.1 Report outline

This futures technical report is designed to provide information and insight into the *Powering our Lives* project development processes. The report covers the development of both the 'technology roadmapping' phase of the project (completed with the assistance of Cambridge University's Institute for Manufacturing) as well as the development of the scenario narratives, produced by Henley Centre HeadlightVision. The Office for Public Management contributed initial research on the drivers of change influencing energy management and the built environment. This report is designed to provide an overview for non-experts in scenario planning and technology roadmapping processes.

This document focuses on the development of the scenarios. It also contains a mixture of tools, techniques and guidance to help policymakers, stakeholders and other interested parties interpret the scenarios and use them as part of a strategy or policy development process. It does not contain the full and final set of outputs from the project, which are covered in the final project report.

2 Scenario planning: an overview

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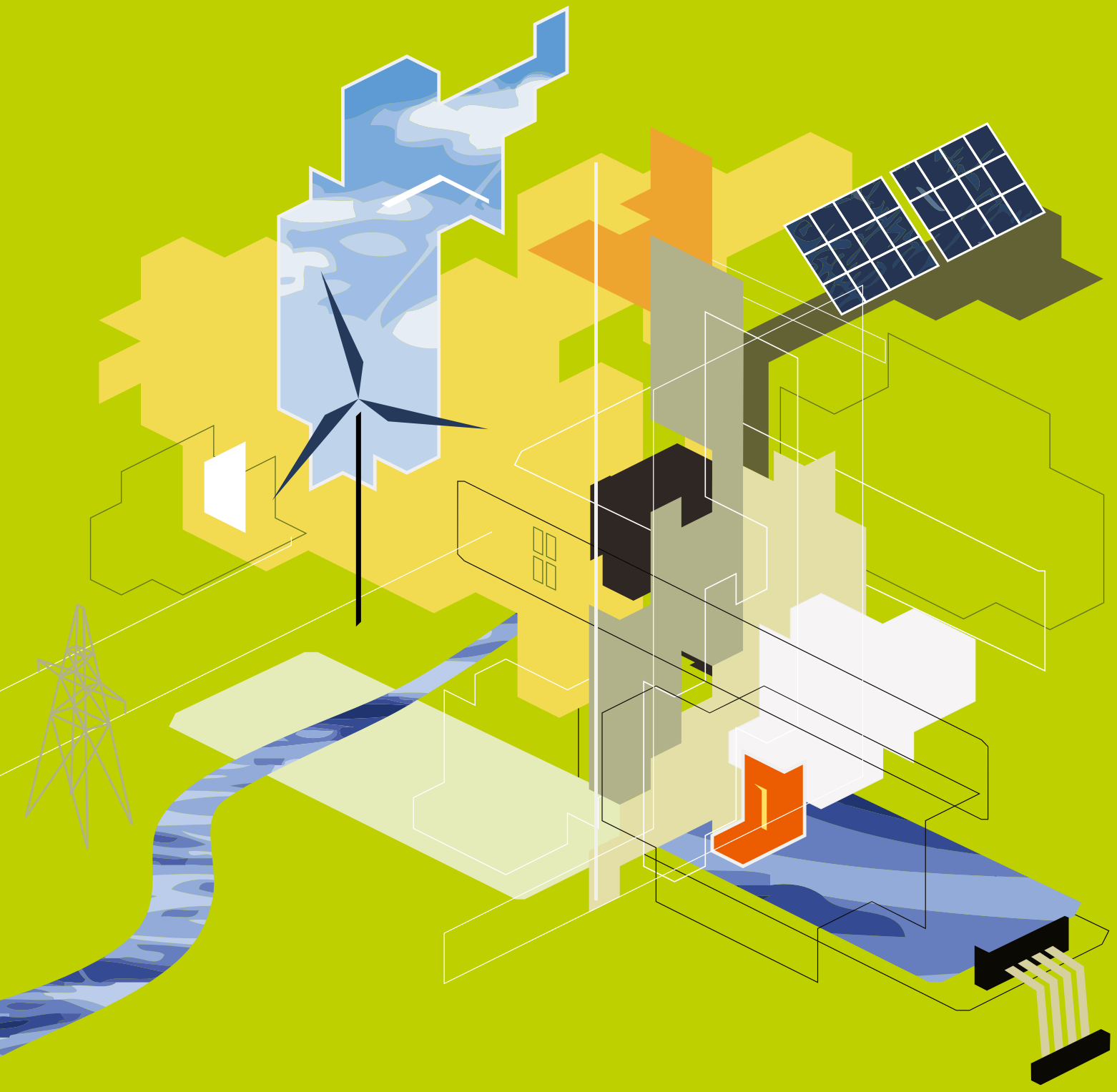


2 Scenario planning: an overview

2.0 Introduction

Scenarios are a tool for thinking about different possible futures and can be used to inform policy making. Using scenarios to explore and rehearse uncertainties may highlight a number of issues or potential options which require further detailed investigation or analysis (often using more conventional strategic and analytic tools).

Scenarios are most commonly used as an analytical tool in a strategic context, for example:

- to broaden and deepen the way in which organisations sense their external environment, and then to connect this to the way in which they respond to these stimuli;
- to help define future vision and strategic priorities;
- to rehearse different policy options to highlight potential strengths and weaknesses, or unintended consequences; and,
- to future proof a decision or potential investment that is 'on the table'.

2.1 Note on the scenarios method used

The Sustainable Energy Management and the Built Environment scenarios were developed through a 'deductive' process, based on techniques developed initially by SRI (originally known as the Stanford Research Institute) in the United States, and evolved through practice by the Global Business Network.[1] [2] In the UK, Europe and the USA this is the most widely used scenarios approach. It creates the familiar '2x2' scenarios matrix which captures four differing possible futures by exploring critical uncertainties.

It is described as a deductive process because the scenarios are 'deduced' from an analysis of the drivers of change. The drivers which are both important and most uncertain are prioritised, then analysed to identify the two most significant uncertainties, which represent the familiar 'scenario axes'. The scenarios are then derived deductively through exploring the outcomes when uncertainties at each end of the x- and y-axes are combined. (In other processes, known as 'inductive scenarios', the scenario-building process develops through interpretation of data, trends, and other material, often by a core or expert group).

There are a number of benefits to using the deductive approach. It is a structured process, with a clear flow from drivers to scenarios axes. It also provides a relatively straightforward way to connect the scenarios to their strategic and policy implications. Finally, because it is widely used, the process is more familiar to participants who are unlikely to have deep familiarity with futures methods.

1 The GBN process is summarised in Gill Ringland (2006).

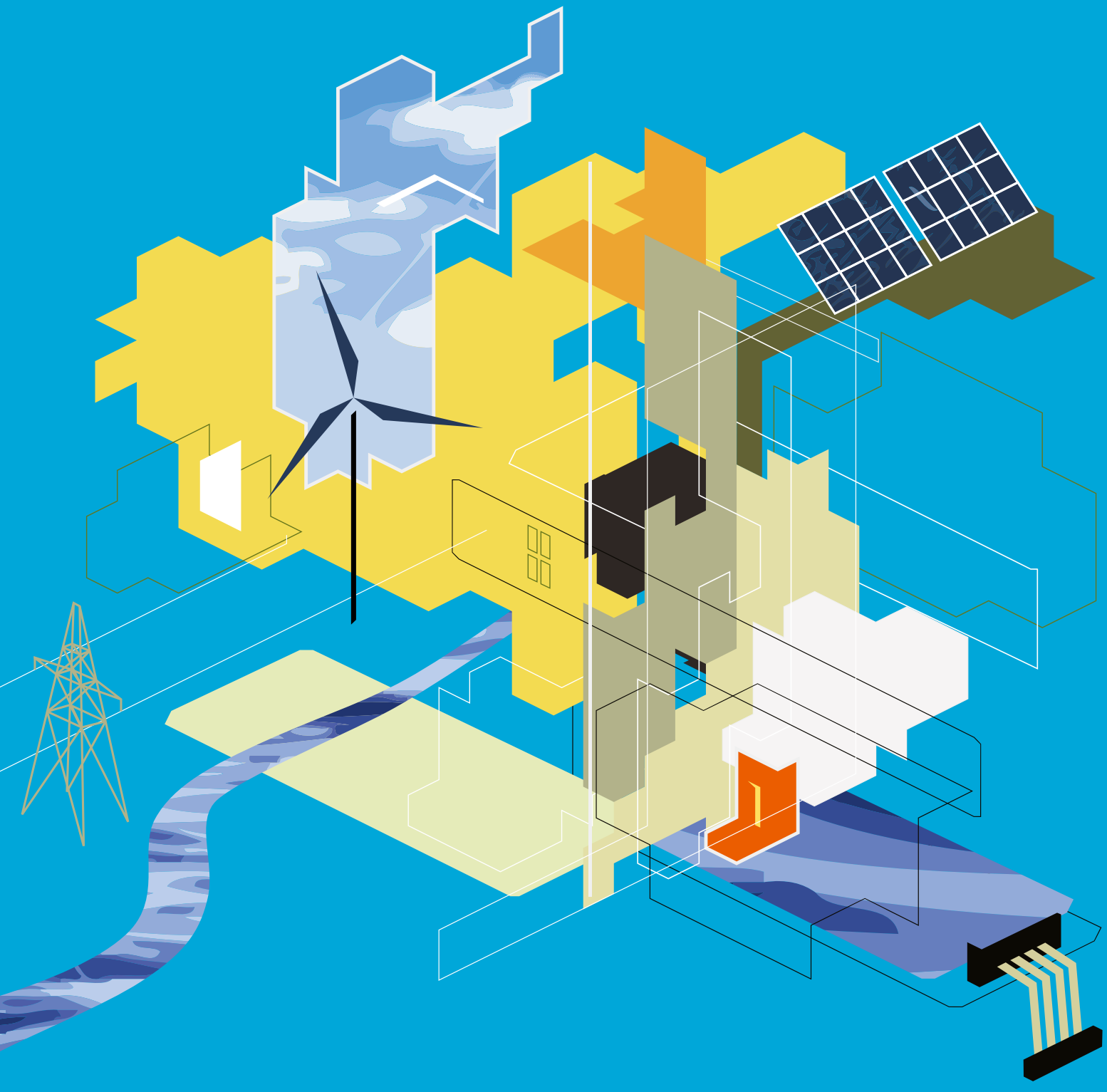
2 The SRI's process is described in Ian Wilson (1998).

3 Developing the Project's scenarios

3.0 Introduction

3.1 The scoping question

3.2 Initial drivers identification and analysis



3 Developing the Project's scenarios

3.0 Introduction

The development of the Project's scenarios followed a five-stage process which is outlined below. It was designed to engage relevant stakeholders in a process first of co-creating the scenarios, then building a shared view of the potential futures around sustainable energy management, and finally, testing for a range of policy implications.

There was a high level of both stakeholder and expert contribution throughout. This was based on previous scenarios experience, and theory, from which we learn that scenario construction is a process of social knowledge production in which new knowledge emerges from testing 'public knowledge' (e.g. the evidence base) against 'internal knowledge' (e.g. individual expertise and experience). Further, such a process is essential to develop confidence both in the scenarios and in the strategic implications that emerge.

The bullet points below outlines the main stages, which are described in more detail in the rest of this report. In summary:

- At the start of the process, a scoping question was agreed;
- An initial set of drivers of future change was developed;
- On the basis of those drivers which were prioritised through the drivers workshop, and identified as both important and highly uncertain, initial options for scenarios were developed and reviewed;
- A set of initial scenarios was then developed, tested and refined further through a second stakeholder workshop, to create a set of future scenarios and initial narratives. These scenarios evolved further through interrogation in additional workshops. At the same time, a parallel workstream by Cambridge University's Institute for Manufacturing developed a set of exploratory technological roadmaps, again using expert input and workshop discussions. They were designed to highlight potential technological developments during the timeframe of the scenario narratives.
- Further analysis of the scenarios was then done to evaluate some of their potential implications on policy.

3.1 The scoping question

The framing of a project question is essential to effective scenarios work, because it defines the overall range of the project. The question in this case was around the future of the built environment in the context of the growing need for sustainable energy. (See Section 1.0).

This was developed through experts and workshops, and was used to guide the rest of the scenario development process.

The benefit of a broad project question is that it enables considerations of the wider futures landscape. This therefore includes within its scope multiple different sustainable energy management solutions. As Peter Schwartz cautions, "Frequently, people develop scenarios for a small focussed situation and discover that it is affected by much larger issues. Worse still, they may not see those wider ramifications."[3]

3.2 Initial drivers identification and analysis

Following agreement on the project question, the project team worked to identify major 'drivers' of future change. These were framed using the so-called 'STEEP' categories: Social, Technological, Economic, Environmental, and Political.

'Drivers of change' are forces (which can be social, technological, economic, environmental, or political) which are likely to influence the outcome for the overall system or subject defined by the project question over the specified time period. They may influence it positively or negatively. In addition, a driver of change can be characterised by the way it impedes the rate of change: e.g. 'the low rate of investment in new technology'. The processes of first scanning for drivers, and then analysing them for importance and degrees of uncertainty, are the platforms on which scenarios work (and futures work more generally) are based.

This section of the research was primarily completed by the Office for Public Management, who completed a literature review of 27 studies in order to identify some of the major factors and drivers included in other appropriate futures reports. The studies selected for this project (see Appendix A) were chosen because they adopted a futures perspective, focused on energy management and the built environment, and between them covered a broad range of methodological approaches. This led to the inclusion of studies which had a somewhat broader focus, rather than studies which dealt with more specialised aspects of the built environment or energy management.

The analysis identified seven major 'clusters' of forces, drivers and trends pertaining to sustainable energy management and the built environment from the literature:

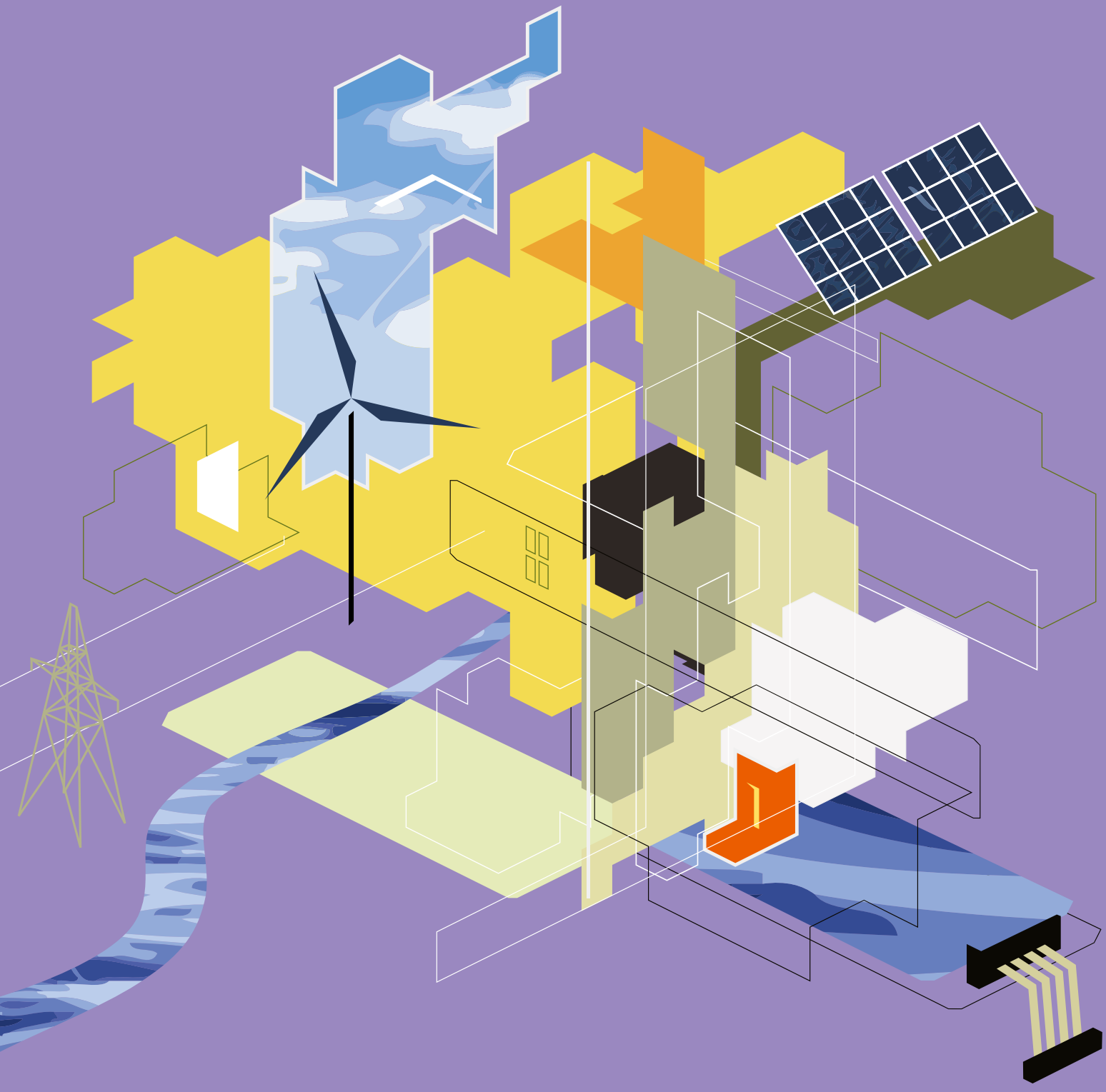
- Climate change and the environment;
- Demographic change;
- Infrastructure;
- Technology and materials;
- Public attitudes;
- The economy (market forces);
- The political framework.

3 Schwartz (1997)

4 The scenarios

4.0 Developing the scenario axes

4.1 The scenarios



4 The scenarios

4.0 Developing the scenario axes

4.0.1 A note on axes development

Some futurists are sceptical about the value of the '2 x 2' matrix as a basis for scenario development. They argue that it tends to produce at least one scenario which is 'too good to be true', and one which is clearly to be avoided. In its public policy scenarios, Shell has sometimes presented only two scenarios (as in its most recent global energy scenarios).[4] However, the matrix has some significant benefits in improving the ability of an organisation or network to visualise the future, and therefore to respond. The scenarios effectively represent the 'corners' of the futures space (where the uncertainties combine in the most extreme fashion), so the classic matrix effectively reveals most of the futures space to participants in a more transparent fashion.

But although the topic of the development of axes is one in which there is much practitioners' lore, it seems to be relatively absent from the literature. It is obvious that rigour is required if they are to be effective in creating scenarios which carry within them the potential for action. Equally obviously, the axes need, as far as possible, to be 'orthogonal' (they must represent distinctively different uncertainties which do not collapse onto each other). They also need to create space in the scenario quadrants – in a comprehensive manner – for all of the drivers which have been identified as both important and uncertain. This leads to a preference for 'rich' axes, which have some complexity embedded in the uncertainties, and which sometimes require a degree of explanation, rather than simpler ones. But it also seems to help fulfil the third criteria, which is that each of the scenarios needs to include both elements which are regarded as positive and elements seen as negative, certainly over the life of the scenario narrative. One reason for this is that trends are never inexorable; sooner or later they prompt a reaction.

The final requirement is that the scenarios which are generated by the axes need to be strategically interesting in addressing the scoping question. There is usually more than one set of axes which fulfil the first three criteria. The final selection is a matter of judgment; art as much as science.

4.0.2 The scenario axes

The scenario space is defined by the juxtaposition of two 'axes of uncertainty' derived by clustering a series of prioritised drivers (outlined in more detail below) into key opposing dimensions.

The 'x' axis describes the significant uncertainties in the global political and economic context in 2050. It explores the extent to which nations and regions are willing to enter into relationships with their counterparts to trade and to collaborate. At one end of the axis there are 'open and interdependent' relationships, usually involving multi-lateral agreements or institutions, at a global or regional (i.e. continental) level. This is broadly an open, collaborative and globalised world. There is an appetite for political and or academic/scientific collaboration, multi-national and bloc agreements, and relationship building. Applications developed elsewhere are more likely to be imported into the UK.

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4 Shell Energy Scenarios to 2050

At the other end of the axis, in contrast, states (and even regions within states) are 'bounded but independent'. Relationships with other jurisdictions are more likely to bi-lateral than multilateral, and more likely to last only as long as is useful to both parties. However, it is important to emphasise that these are not 'autarchic states'; they do not seek self-sufficiency or closed borders. Bilateral and ad hoc coalitions and agreements take place to facilitate the sharing of technologies, knowledge and skills, but use of these is highly filtered for those elements or details which can improve the effectiveness of a local application. States and regions are, however, concerned that economies and borders that are too interdependent – in a times of significant resource pressures – could be too exposed to risk of collapse.

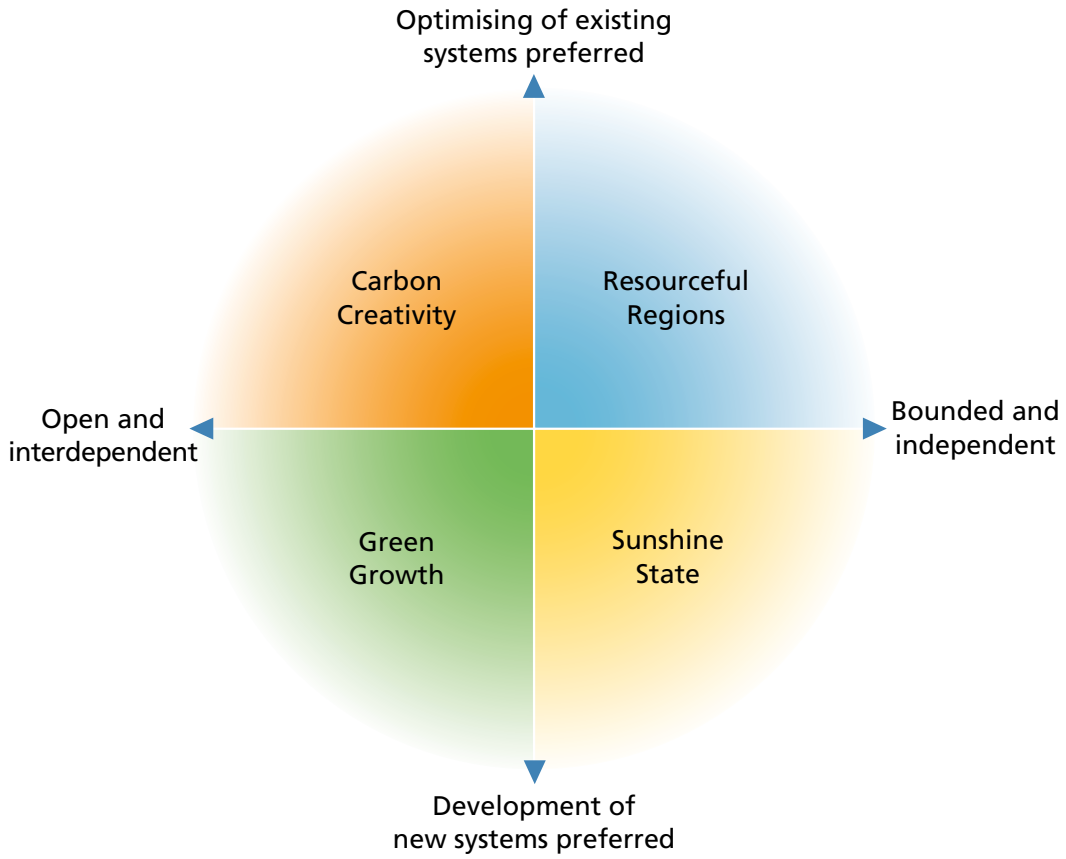
The 'y' axis looks at the type of innovation which attracts investment. At one end of the axis, policy-makers, regulators and investors prefer to foster new systems. Priority is given to emerging systems and technologies. There is a preference for novelty. The reasons for this include, from the policy and regulation perspective, a belief that the requirements of meeting carbon reduction targets, and matching energy use to supply (whether through increases in generation or reduction in demand), require more radical solutions than can be delivered through adaptive technologies. From an investment perspective it is driven by a combination of policy and regulatory signals, and by a view that only new technologies are likely to provide reasonable rates of return over time. However there is also the likelihood of a bigger negative outcome if they go wrong.

At the other end of the continuum, the emphasis is on deploying innovation for optimising existing systems, whether in energy, buildings, or the built environment. This could represent a rational policy response; in the face of energy shortages, in particular, government may well believe that it is more likely to achieve its targets by aligning itself with existing technical expertise and systems within the existing (large) companies, and by making incremental changes to infrastructure, thereby placing such systems under less stress. There are risks; for example, the technologies for carbon mitigation and management may be less effective than advertised.

It should be underlined that in terms of both energy and the built environment, these uncertainties represent 'centres of gravity' rather than being exclusive, e.g. there are some renewable technologies to be found among the 'existing systems' at one end of the axis. At the other end, existing fossil fuel-based generation does not simply vanish, although they do get phased out over time. The difference between the ends of the axes is one of scale. It is assumed for example, that if innovation investment (and policy attention) is being directed towards cleaning and greening existing energy supplies, then this will remove significant funding, and policy initiatives, from new systems. (And, at the other end of the axis, vice versa).

The scenario axes are outlined below in Figure 4.1.

Figure 4.1: 2x2 axes of Project scenarios



4.1 The scenarios

The full scenario narratives, as used in the final stages of the project to evaluate and explore impacts and policy principles, are included in Appendix B. For the purposes of illustrating some of the project output in the body of the report, we have included summaries of the four scenarios, and some short 'vignettes' produced as part of the workshop process which were designed to capture explicitly impacts on the development and management of the built environment.

4.1.1 Resourceful Regions

This is a world in which political trust has diminished on a world scale, although bilateral agreements and trade continue. Most UK energy comes from fossil fuels with innovation being focused on the optimisation of existing systems. They are used more efficiently than in the past, but the focus of attention is less on the global impact of climate change and more on energy security and the cost of fuel. Electricity networks have become more intelligent and adaptive to allow power to be used as efficiently as possible. The key distinguishing feature is that English sub-regions have a high degree of autonomy, matching Scotland and Wales. In situations of resource scarcity, regional trade in fuel and water carries considerable leverage; water is now widely understood to have an energy cost. This has meant a resurgence of industrial activities such as deep and open-cast coal mining in areas where they had previously died out. Some regions do deals with overseas countries on energy supplies. Regional deals for permitting new power station developments have meant that nuclear power still plays a role but many regions have also invested in appropriate renewable technologies for their area.

The countryside is used more intensively than in the past, for food production, mining and other activities. Within built up areas, retrofitting rather than new build is the preferred approach. Any new buildings are increasingly built in a local vernacular style, and there is considerable emphasis on urban green space to tackle overheating. People in this Britain like to think they are self-reliant, and are proud of being British, even though the country is closer to breaking up than any other time in the previous century. Their living conditions vary widely as regions have their own economic structures and differing levels of economic success. But acceptance of the situation is underpinned by strong regional identities and the effectiveness of most regional government's moves to support vulnerable groups and public services such as public transport.

Figure 4.2: On the dock of the bay – 2050

On the dock of the bay – 2050

On the dock of the bay – 2050

It is perhaps appropriate that the Bute Docks in Cardiff, once the busiest coal port in the world, now looks out over Cardiff's tidal-powered energy station. The project has been many years in the making and there has been much dispute about its impact on the earlier Cardiff Bay development – more oriented towards leisure and housing – of the late 20th Century. But in the end, the City Council and the Welsh Administration agreed that energy needs meant that they should utilise the resource that was almost on their doorstep.

The plant powers the local electric tram network, around Cardiff and across much of south Wales. The hydrogen to power the City's buses comes from the re-purposed gasometer overlooking the bay, once thought ugly, now a symbol of the City's relative levels of energy independence. The dragon on its side can be seen in England on brighter days – a constant reminder of a more heralded but now, in the face of environmental damage, unstable Avon-Welsh agreement over the location of the energy station.

The fact that Wales has got tidal power to work ranks as one of the Administration's finest achievements. Many other similar schemes around the world have proved to be less successful. One of the features of the scheme is a research and development centre, affiliated to the University of Wales at Cardiff, and based in the old customs building, overlooking the bay. This building and its surrounding outhouses have been hugely re-purposed for the benefit of the local community – exhibitions by Welsh artists are often on display (a source of considerable local pride). There are frequent school trips to the facility, in order to help children understand energy, where it comes from and how existing energy systems can be modernised.

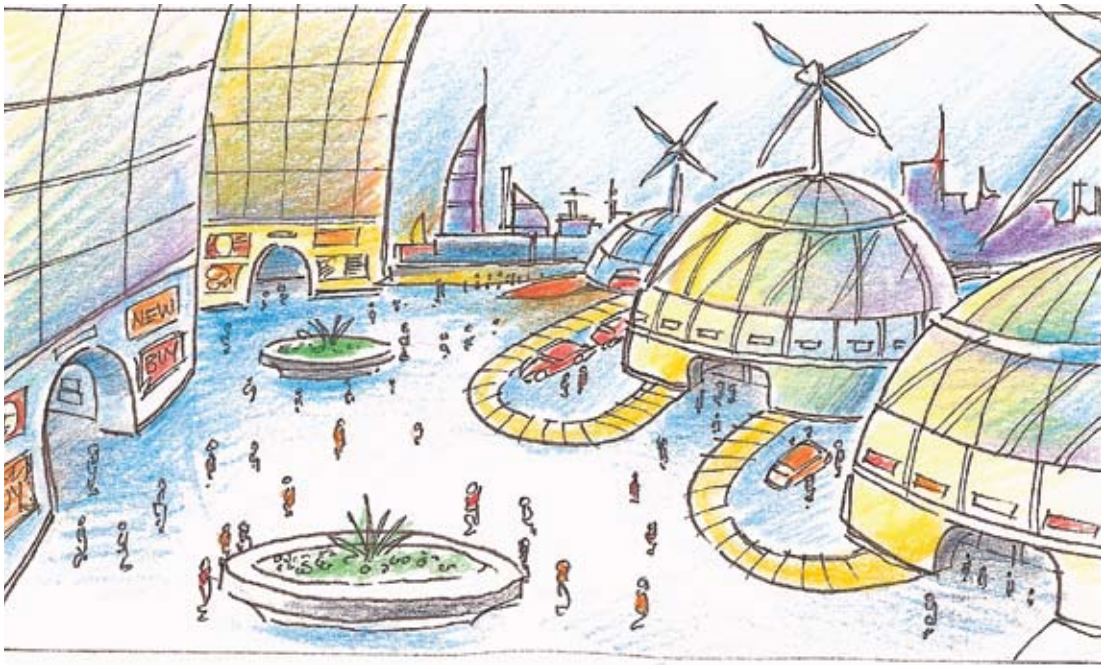
4.1.2 Sunshine State

International solidarity has fallen by the wayside in response to climate change and expensive energy. Instead the Government has fostered an emphasis on localism to respond to energy problems supported by a shift in social values after a period of outages and fuel shortages. A Sunshine Index is the main metric of progress, not Gross Domestic Product. Home insulation and other energy efficiency measures are universal following strong regulation. Retrofitting is sometimes done alongside adaptation work to help buildings cope with warmer and wetter conditions. Green roofs and parks are common as part of comprehensive local sustainable drainage systems to counter flooding. There are more local shopping streets and other community resources, partly because of planning decisions intended to promote local autonomy and partly because of municipal enterprise. New build commonly uses off-site construction methods, often from overseas.

People are active energy users and know about the energy use of everything they own. They know their neighbours, who are important to them economically as well as socially; people travel less widely. Many belong to local 'time banks' (where people use their time, rather than currency, as a form of transaction) or use local currencies. Innovation has led not only to the introduction of novel technologies but also new organisations, ideas and approaches. There has been considerable expansion of renewables including solar energy and biomass. Bulk electricity storage has become more practical alongside virtual storage, and costs for solar power have come down radically. Gasification, pyrolysis and other creative ways of using biomass and waste to generate energy have been

developed successfully. A new cohort of energy and environment professionals has grown up to address earlier skills shortages and government has been actively involved through nationalisation of the grid and municipally-owned local energy schemes. Energy markets are also closely regulated and reserve powers of rationing energy and water exist.

Figure 4.3: Edge of town – 2050



Edge of town – 2050

The edge of town – 2050

Out of town supermarkets have long since closed, in a world in which energy was scarce and its use discouraged. But retail sites on the edge of town, or in town, have gone through successive mutations. The first – and most obvious – iteration was to become primarily a distribution hub for goods rather than a shopping destination for consumers, with the retailers effectively using them as distribution warehouses, a model which substantially reduced energy costs.

The second stage added people to this mix. People still need to travel, but they now tend to travel more slowly and to stay longer. The supermarket sites had sufficient space, in the car park and elsewhere, to build sophisticated and desirable self-contained 'living units' for students, key workers, and other visitors. These units have access to communal power sources – usually self-powered from solar strips and wind turbines on the roof, energy storage and rain water collection reservoirs. A shared canteen is supplied from the warehouse. Advances in ICT and telecommunications allow the residents to be fully networked and integrated into their respective communities, both physically and virtually. Sound insulation, separating the living units from the work of the warehouse, has been a prerequisite for success.

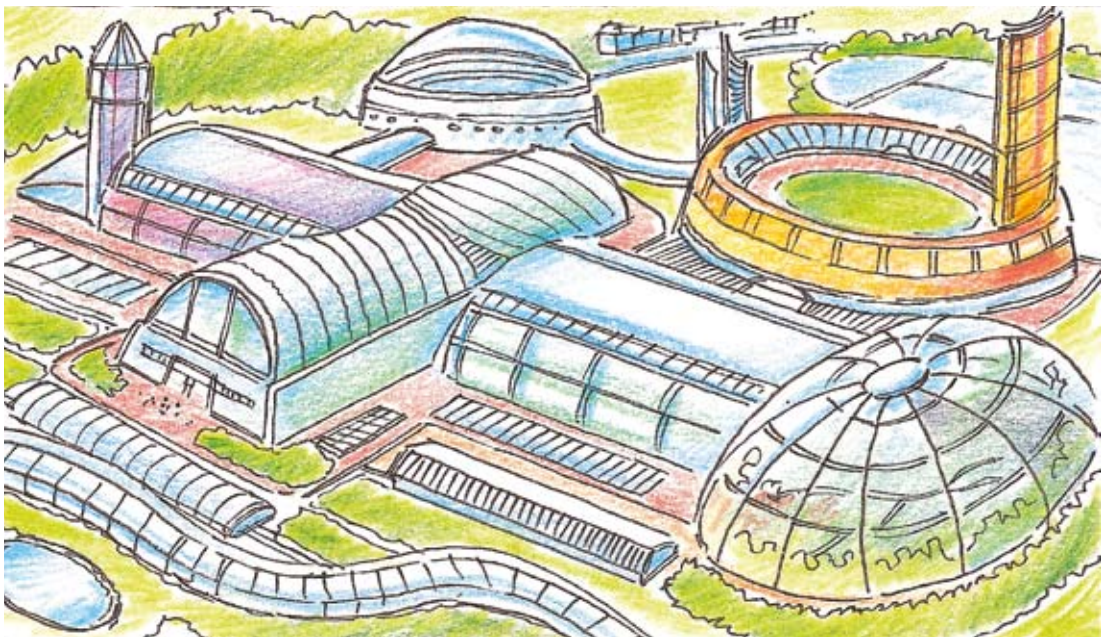
In many places it's a comfortable walk to the town and business centres. But there are usually car-sharing clubs based at the site, and sufficient density and demand to ensure that the local bus and tram connections work well.

4.1.3 Green Growth

In this world, fossil fuel depletion and climate change are serious concerns and novel technologies and systems are regarded as the way to deal with them. Social values emphasise universalism and benevolence. There is an emphasis on decoupling economic growth from carbon emissions and a substantial carbon tax to drive change. By 2050 the building industry reflects these developments although it took time to achieve a step-change within the UK. Strong planning powers and public procurement focussed on carbon reduction led to much penetration by overseas companies in the early years. However there are now many highly energy-efficient new houses and other buildings. New designs, particularly for offices and shops, had to take on board the banning of all air conditioning. There is less emphasis on retrofitting old property and, as a result, these have fallen considerably in value.

People take responsibility for their energy use supported by energy avatars and have become much more active consumers. Most energy comes from renewable sources including big projects such as the Severn Barrage, offshore wind farms, and solar energy farms in Africa. Strong planning powers were used for the UK schemes. There is some local renewable energy, including energy-from-waste schemes, partly to offset the inherent instability of electricity supplies transmitted across thousands of kilometres. In response to such insecurities, energy use is managed automatically, for example, by turning off freezers and washing machines at times of peak demand.

Figure 4.4: Green Growth – 2050



The glass palace – 2050

The glass palace – 2050

One hundred and ninety years after the original building was moved to the site, the Crystal Palace has been rebuilt and re-opened in the Park, on the same site, as a symbolic showpiece of the commitment to energy and service innovation. It was built by an international team of architects, engineers and energy companies from the UK, Europe and China. The building combined the London bio-dome with exhibition space showcasing the latest developments in renewable energy and conservation, a sports hall and a concert hall. New research facilities – linked to Kew Gardens and to the global Eden Project – have also been sited here.

Even such a prestigious project has had to fight its way through the rigorous planning, procurement and building management process. No new building can be commissioned without a government-approved maintenance and management contract with a MUSCO (a multi-utility service company) which will ensure that energy, water and resource management, together with maintenance, complies with current performance standards, including the capacity for remote monitoring and management. In the water-stressed capital, a new building of this size has to be able to pay its way by putting on equivalent amount of resources to the amount it consumes back into the resource network. Rainwater capture and use of renewable energy were part of the original design, although it took several redesigns to release enough resources to local buildings to 'fund' the incoming water demand.

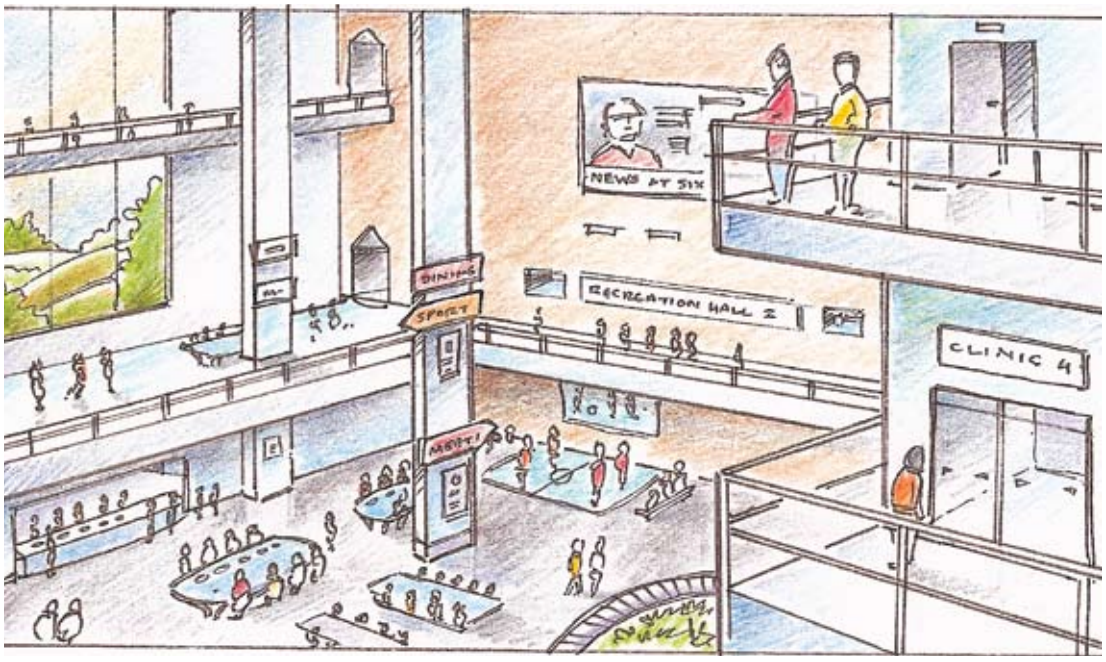
The sports hall floor has been constructed using smart materials which can be adjusted to suit the particular event that's taking place, while the pathway from the refurbished integrated transport hub has been built from recycled self-healing 'stone' – an artificial surface which is designed to regenerate after wear.

4.1.4 Carbon Creativity

Decarbonisation is a major theme in this world, prompted by a carbon market in which all goods and services carry a carbon price. However, it has been possible to combine this with a continued reliance on fossil fuels due to considerable investment in Carbon Capture and Storage. Renewables are small in scale and volume and little renewable power is connected to the grid. The economy faltered for a while in the transition to this new technology and carbon-driven economy but has now recovered although there is general acceptance that there will not be a return to high levels of growth. People in this world are highly aware of energy in the form of embodied carbon in everything they produce. They are also conscious that energy is expensive. On a more positive note, there has been a boom in carbon consultancy, in which there are European Union-recognised qualifications and London is the centre of world carbon trading. Europe also plays a major role in regulating energy markets.

Energy costs and regulation have driven considerable retrofitting and renewal of the existing built stock, both domestic and commercial. The construction industry responded well to poor standards and practices in the early days and the quality of work now delivers considerable carbon savings. High-density, mixed-use developments are popular because of their community feel as well as their energy efficiency and proximity to transport nodes. They feature optimisation of existing technology for capturing energy, especially from solar power, and for using it effectively, for example advanced glazing. Following a steep learning curve, local planning has ensured that these new development deliver on all these fronts as well as being adapted for climate impacts.

Figure 4.5: The clinic by the park – 2050



The clinic by the park – 2050

The clinic by the park – 2050

The conversion of one of the PFI hospitals built in the early 21st Century into a mixed-use health/home/living complex made sense when one considered how many people worked there – and the transport and energy infrastructure which went with it. The carbon market – and better health monitoring – meant that there was more demand for local rather than centralised health services. At the same time more of the hospital's own staff needed to be able to live close to work to make it an affordable proposition.

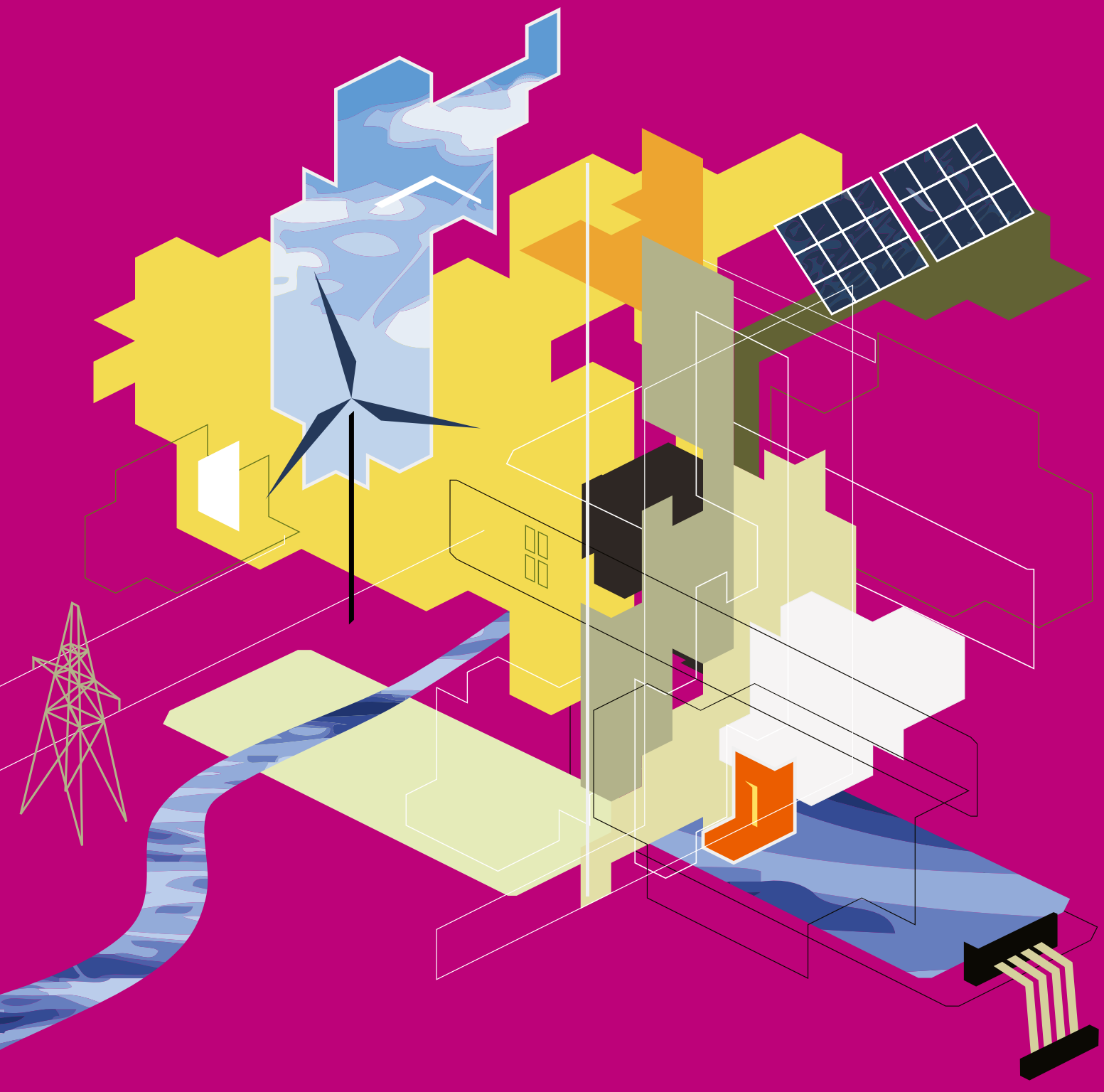
While much of the living accommodation had to be converted to meet new building standards, one of the most intriguing features of the new developments was the integration of shared space and facilities. Much of this benefited from the facilities already in place within the hospital, with some needing to be developed from scratch, albeit by adapting existing space within the former hospital buildings (given the high carbon costs of demolition and new build there was a premium on renovation whenever it was an option). As well as shared cleaning facilities there were also shared canteen facilities which were welcomed by many as a way of having a social life close to home. Other resources simply reduced the need to travel for entertainment, such as the virtual reality internet, where people can engage in team sports such as football, cricket and netball without leaving their houses.

Although a planned shared social space was repurposed – some users found it too reminiscent of student life, others failed to treat it with the necessary respect – a club space which was bookable for different interests (with members on the site and in the locality) was used by many groups, from religious, cultural and environmental interest groups, to the home-carbon-traders group, the book club and continuing education.

5 Technology roadmapping

5.0 The purpose of technology roadmapping

5.1 The roadmapping process



5 Technology roadmapping

5.0 The purpose of technology roadmapping

In parallel with the development of the scenario narratives, a process of technology roadmapping was carried out by Cambridge University's Institute for Manufacturing. The process was designed to challenge and refine the outputs from four scenario-based roadmaps for sustainable energy and the built environment to 2050, and in particular to ensure that the latest thinking around the evolution of particular technologies informed the scenario development process.

The literature on the roadmapping[5] highlights a number of benefits to this approach. Within single organisations and in the commercial sector such benefits include:

- Many benefits derived from the roadmapping process rather than the roadmap itself. The process brings together people from different parts of the business, providing an opportunity for sharing information and perspectives. The main benefit of the first roadmap that is developed is likely to be the creation of understanding around a common framework for thinking about strategic planning in the business. Several iterations may be required before the full benefits of the approach are achieved, with the roadmap having the potential to drive the strategic planning process.
- The roadmapping process provides an effective means for supporting communication across functional boundaries. Roadmaps should be multi-layered, reflecting the integration of technology, product and commercial perspectives in the firm. The structure that is adopted for defining the layers and sub-layers of the roadmap is important, and reflects fundamental aspects of the business and issues being considered. Typically these layers relate to key knowledge-related dimensions in the business, sometimes characterised as 'know-why', 'know-what', 'know-how', 'know-when', 'know-who', and 'know-where'.
- Roadmaps provide a means of charting a migration path between the current state of the business (for each layer), and the long-term vision, together with the linkages between the layers.

5.1 The roadmapping process

The process used by the Institute for Manufacturing was designed to capture the technologies that underpin the scope of the project (for example energy, construction), as well as constraints and enablers that are anticipated to influence their deployment and take up.

This task was completed via two workshops with stakeholders, during which expert participants reviewed each roadmap against a scenario, to identify inaccuracies and missing applications and technologies. The workshops were was designed to review the required applications, their underlying technologies and development resources in sustainable energy and the built environment against the draft scenario narratives.

5 Phaal et al. (2001)

A range of emerging conclusions was reached through this process:

- A number of applications were relevant to multiple scenarios. These included: appliance and carbon labelling; compact fluorescent lamp and light emitting diode low-power lighting; demand-side management; improved Combined Heat and Power plants; design for extreme environments; improved controls and efficient boilers; retrofit insulation; life cycle analysis; proactive distribution networks; and smart metering.
- Technologies which were broadly applicable across the scenarios include: improved heat pumps; local energy storage; smart metering; smart plugs and flexible tariffs for demand management.
- The significance of existing technologies, resources and legacy assets was also emphasised, for example in the role of nuclear power and coal, and challenges relating to ageing building stock.
- Workshop participants also brought forward some further thoughts on the scenarios, including the role of political intervention and fiscal incentives; relationships between UK and the global community; public opinion and behaviour, and the broader interaction of energy and other economic indicators.

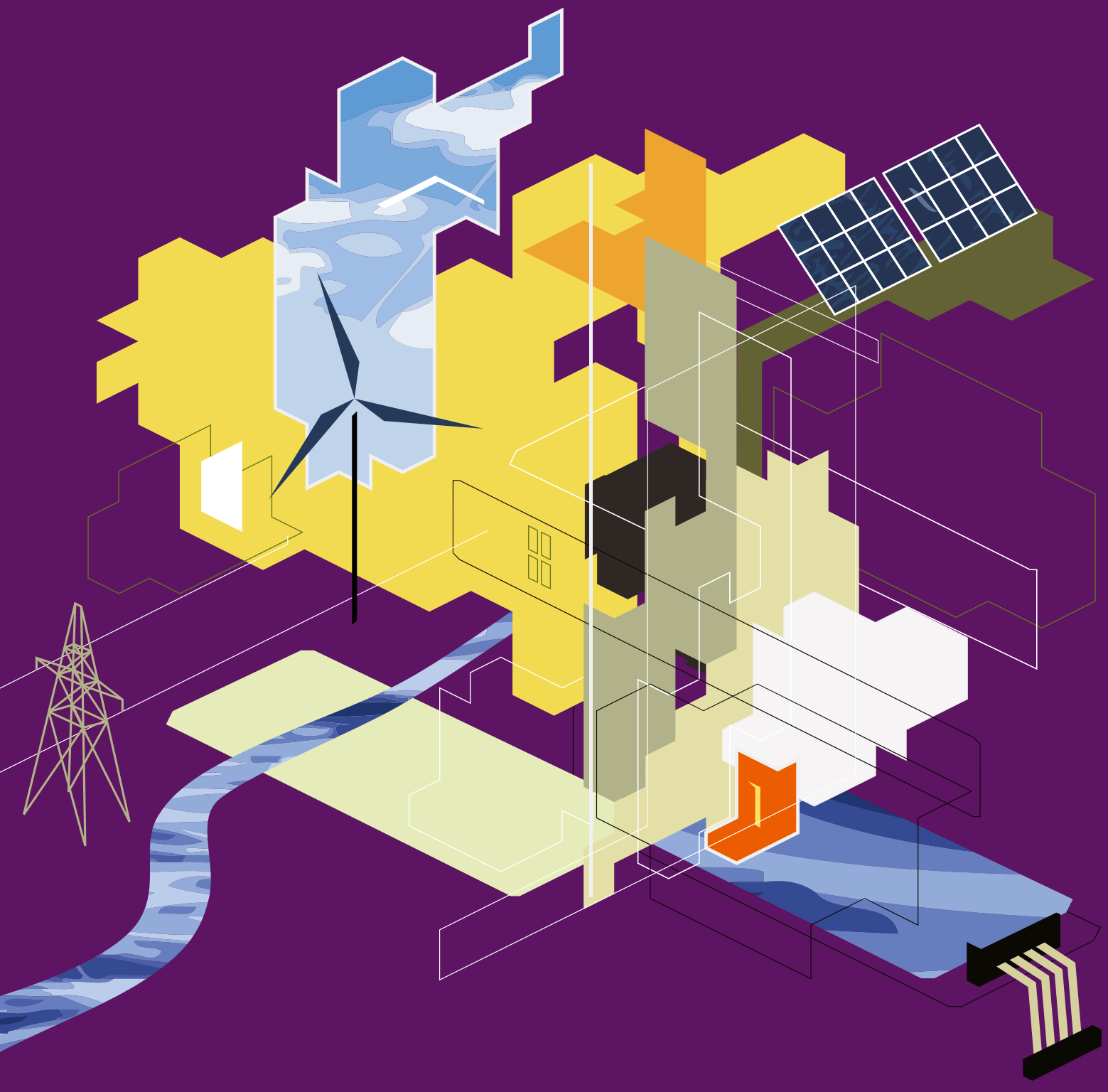
The outputs of the roadmapping process were fed into the development of the scenario narratives.

6 Working with the scenarios

6.0 Integrating scenarios with strategy formation

6.1 The windtunnelling process

6.2 Windtunnelling workshops



6 Working with the scenarios

6.0 Integrating scenarios with strategy formation

One challenge in using scenarios is to connect effectively the narrative and descriptive forms developed with the analytical frameworks required for strategy and policy work. This is particularly important as scenario planning should not be seen as a separate part of the strategy- and policy-making process, but rather as part of a broader process. Moreover, it is in this area that scenarios typically gather the most traction with policymakers.

There is a range of different techniques which can be used to integrate scenario narratives with strategy (see Appendix C). In the case of the *Powering Our Lives: Sustainable Energy Management and the Built Environment* scenarios, a process of 'windtunnelling' was used experimentally in 2 small workshops to illustrate the possibilities.

6.1 The windtunnelling process

Windtunnelling as a technique for testing policy was initially described by Kees van der Heijden,[6] and refers to a process whereby policy or strategic options are tested across a set of scenarios to see which are robust across a range of future outcomes and which are not. The metaphor is from the way in which the design of a car, a plane, or indeed the position of a racing cyclist, is tested in a 'wind tunnel' and its design improved as a result.

The process is used to help policymakers test potential policies against different scenarios. At the top level, windtunnelling aims to identify policy options which will produce positive (or at least neutral) outcomes across all four scenarios. It also helps to position policy appropriately in relation to policy options which seem strong in some scenarios but are poor in others, by concentrating policy-making attention on strategies which enable one to opt in or out of a policy if circumstances change.

In a short paper De Ruijter and Janssen compare this to the type of financial options which are traded, and identifies three types of policy options which are designed to improve strategic flexibility.[7]

- 'Control options': start, stop, place on hold (stop temporarily), delay, restart.
- 'Switching options': where the level of implementation can be scaled up or down with a modest risk or cost, or switched between inputs. (For example the car production line that can make family saloons or pick-up trucks depending on relative demand).
- 'Platform options': investment in capabilities that can be scaled up if necessary (for example the acquisition of a solar panel company by an oil company).

Each of these can be associated with particular windtunnelling outcomes. Monitoring and evaluation capacity is necessary.

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6 Van der Heijden (2004)

7 De Ruijter and Janssen (1996)

6.1.1 The evaluation process

The initial evaluation is a simple scoring exercise, using an assessment table based on a scale from "++" (very positive) through "o" (neutral) to "– –" (very negative).

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Strategy *a*	**+ +**	**+**	**o**	**+**
Strategy *b*	**–**	**+ +**	**–**	**o**
Strategy *c*	**– –**	**o**	**–**	**– –**
... Strategy *n*	**+ +**	**–**	**+ +**	**o**

In this table, *Strategy a* is robust (i.e. positive or neutral) across all scenarios; *Strategy b* is positive in one, neutral in one, and negative in two; *Strategy c* is negative in three and neutral in one; and *Strategy n* is positive in two, neutral in one, and negative in one.

Following this technique, strategic responses can be graduated according to their potential impact across a range of scenarios:

Category 1. Any strategy which is robust (i.e. positive or neutral) across all scenarios should be captured – after checking the assessment. This should go to the implementation stage.

Category 2. Any strategy which is negative or neutral across all scenarios should be discarded – after checking the assessment.

Category 3. Any strategy which is mixed but more positive than negative (positive in two or three scenarios, and with stronger positive impacts than negative) should be assessed in a two stage process:

- First, looking at the scenario against which it is negative, can it be improved or developed so it is neutral or positive, without diminishing its impact in the other scenarios? (If 'yes', send to Category 1).
- If 'no', then how can this strategy be designed in such a way that – in the event that trends move in the direction of the scenario in which it is 'negative' – it is possible to move away from the scenario without having incurred huge costs?

Category 4. Any strategy which is mixed but more negative (positive in one or two scenarios, but with positives totalling 1-2, on a ±2 scale) should be assessed in a three stage process:

- If it has only a 'plus one' positive, is it worth bothering with at all? Assess the likely benefits if the relevant scenario becomes more likely; if they don't appear significant, assign the scenario to Category 2, with a covering note.
- If it is positive in two scenarios, review the circumstances in which it is negative in the others and check that this has been assessed correctly. (If not, send to Category 3).

- If the assessment is correct, then assess how the action can be designed in such a way that it can be implemented if this scenario (or pair of scenarios) starts becoming more likely. Is there a way to disaggregate the implementation so that the minimum necessary part to maintain the capability can be carried out (in a business environment, for example, this may be through acquiring a small company in a niche market which has particular skills or technologies).

6.2 Windtunnelling workshops

Two workshops were held in July 2008 to windtunnel potential policies across the project scenarios. The first workshop was attended by academics, individuals from industry (including energy, construction etc), and those from think tanks and consumer groups. The second workshop was attended by those in relevant policy-making areas within government.

During the workshops, participants were invited to score the impact of each of the sample sets of potential policies against each of the scenarios, in order to identify those policies with a potentially positive or neutral impact across all four scenarios. The workshops were not designed to assess comprehensively a full range of options.

Although specific policies were tested against the scenarios, from a range of actions proposed in the area of sustainable energy management and the built environment, the purpose of this phase of the work was to use this level of relatively granular analysis as a method to gain insight into the principles which should inform policy in this area. A number of such principles emerged from this process.

6.2.1 Understanding the systems

This section explores the main issues identified from these workshops which, in turn, reflect the views of those who attended.

An important set of issues that emerged from the wind tunnelling workshops concerned the need to have an in-depth understanding of sustainable energy management systems as a prerequisite for implementation. In particular, participants highlighted the need to understand at what level of governance any policy interventions would be most effective; how and when 'lock in' could occur; and the need for field trials.

The systems involved in sustainable energy management are complex and interconnected. Participants therefore took the view that different policy interventions to encourage sustainable energy management would work most effectively at different levels. For example, changing energy regulations to encourage the development of energy service providers was a policy that many participants felt would work most effectively if implemented at a national level. By contrast, policies involving 'greening' dense urban areas would likely be achieved in a more effective and innovative manner if responsibility for implementation was devolved to more localised or regional delivery bodies.

Another issue highlighted by participants was the need to understand how and when systems could become 'locked in'. This was viewed as being crucial, especially where the lock in is likely to lead to poor outcomes. Some participants considered that a market-based approach would be the best way to allow future systems to evolve whereas other participants took the view that market-based mechanisms alone could not break out of an undesirable lock-in, so there would be a place for strong, active intervention.

Participants also noted that effective field trials are a prerequisite for successful policy interventions or technical innovation and some felt that government should fund such trials for new or innovative technologies. Government would also need to ensure that the appropriate regulations and institutions are in place to support new innovations.

6.2.2 Incentives and enablers

A second set of issues, raised by participants in the wind tunnelling workshops, concern the importance of understanding how behaviours and values are shaped and shifted over time. Many of the policy interventions discussed would require some form of behaviour change, so an understanding of the potential incentives and enablers for change would be crucial. Particular areas that participants believed would be important to understand were: age-related value changes; behaviours in the planning and construction sectors; the impact of design on the built environment; and costs.

Values and attitudes can change over time. Workshop participants thought that this property could offer an opportunity to identify specific points or life stages at which individuals are particularly amenable to changing their lifestyles or life choices, such as in relation to the environment. Attending school, starting work, having children or retiring could be opportunities for changing habitual energy-related behaviours.

In addition to the behaviour of individuals, participants also identified the impact of regulation on the behaviour of professionals in the planning and construction sectors as an issue that underpins many policy options. They noted that there was a range of structural impediments in regulation on planning and construction that discouraged innovation. Effective restructuring of these regulations would be important in encouraging innovation directed at effective sustainable energy management.

The impact of the design of the built environment on a number of the hypothetical policies was raised in discussions. Higher density urban developments are potentially an effective way of reducing energy consumption and carbon emissions, so ensuring that these are desirable places to live was seen as critical to attracting residents in the future. However, participants felt that people are often put off such developments because they associate high density living with high-rise living and tower blocks. Understanding how to make high density developments attractive and how to frame the discussion about high density living in such as way that avoided negative associations would likely be key to the success of any such developments in the future.

Another significant potential barrier to the implementation of many technologies is their relative cost. Participants believed that the biggest barrier to the implementation of Carbon Capture and Storage (CCS) technology is the cost of installing it compared to the savings generated from the fall in carbon emissions. Similarly, for individuals, one of the barriers to developing more pro-environmental behaviour is the perceived cost of making 'green' choices. In both of these cases, an increase in the price of carbon and the pricing of other externalities should make the green choice more attractive. However, participants thought that getting the prices right was unlikely to be sufficient on its own (a point recognised in the Stern Review).[8] For example, CCS technology has yet to be demonstrated at scale – and therefore needs more specific government support to reduce risks before a carbon price serves to encourage deployment.

8 Stern (2006)

6.2.3 Recognising the starting position

In developing policies for sustainable energy management in the built environment out to 2050, participants thought that it was important to consider the current situation in the UK. Two important issues were raised at the workshops; the need for retrofitting, and developing the skills base.

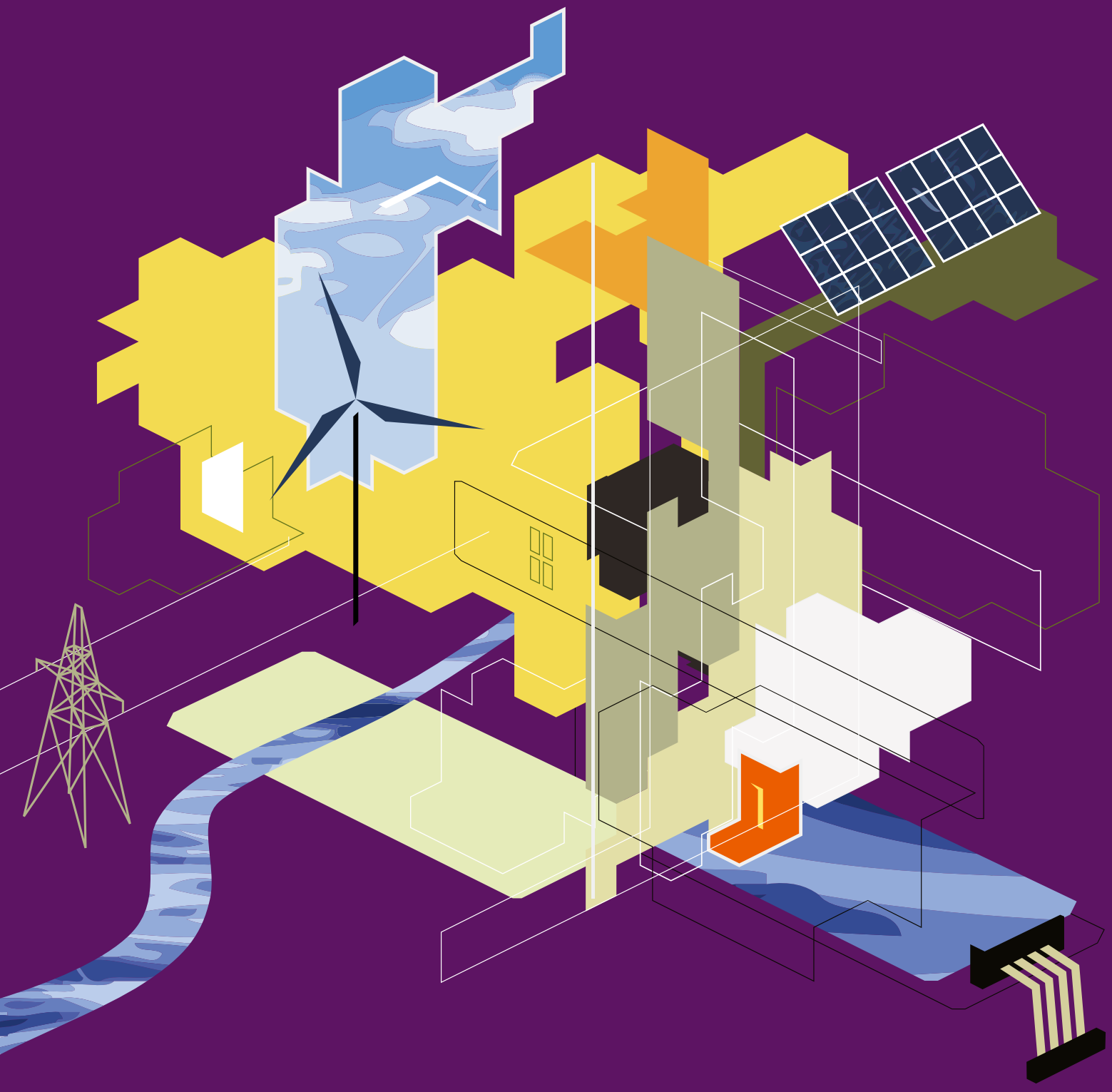
More than half of existing infrastructure will still be in place in 2050, although the precise proportion will vary depending on the level of investment in new buildings and systems. Participants considered that it was important to recognise this aspect, with policies addressing effective retrofitting and upgrading programmes, as well as regulation for new developments. Some participants expressed concern that the focus on improving energy efficiency could be on new build at the expense of improving existing stock.

A number of the hypothetical policy options discussed at the workshops would require an effective skills base for implementation. Participants highlighted the need to bring together the differing skills sets traditionally associated with energy systems, buildings and the environment more broadly. Providing skills and training for those in the construction industries (particularly those in SMEs), for example, was considered a critical success factor for many of the policy options. Participants thought that the lack of skills in the UK building industry for delivering sustainable building design could present a potential blockage to a range of policy goals. Many felt that market mechanisms alone would be insufficient to correct this failure, with there being a need for some form of more centralised state intervention. As it would likely take years to develop new skills bases, it was seen by many participants as a priority for policymakers.

Appendix A: Bibliography of futures studies

Appendix B: The scenario narratives

Appendix C: Working with scenarios: some underlying principles



Appendix A: Bibliography of futures studies

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Appendix B: The scenario narratives

Resourceful Regions

How this world comes about: An international climate of political instability drives energy security up the domestic agenda of most countries. Fossil fuel-rich countries can afford to 'game' at the expense of energy importers by forging and breaking alliances opportunistically. This increases the price of fossil fuel while also reducing consumer, corporate and political levels of trust in the role of multi-lateral agreements and institutions to meet the UK's ongoing energy needs. Low levels of trust have spurred greater national (and sometimes regional) desire for control over decision-making – if countries can't talk directly trust is impossible; bilateral agreements are now more common because a country can walk away if dissatisfied.

During the period 2010-20 competing political and economic models – aggravated by resource competition and climate security – lead to growing instability and conflict. Governmental scepticism about the effectiveness of multinational agreements, and the (un)willingness of other countries and/or institutions to commit to them means that *ad hoc* coalitions, particularly bilateral arrangements become more predominant. Trade at this level remains significant.

An increase in bilateral arrangements can be seen within the UK as well as internationally. The subsidiarity that began with Scottish Devolution and the Welsh Assembly in the late 1990s has continued, with powerful regional assemblies across England, increased powers for the Scottish Executive, and a Welsh Parliament on a par with Scotland's. The UK now has a federalist feel – in common with some of its European Union counterparts. Most of the regional assemblies have used their tax varying powers (to put taxes up, in the main), along with flexing their muscles to regulate service provision and take ownership of significant regional assets.

The regional blocs within the UK have each leveraged their own natural resources such as water, wind, food, coal etc. for competitive advantage. Independence doesn't mean autarchy, but does mean that trading groups prefer bilateral agreements to multilateral ones. To improve their economic performance regions have sometimes been able to draw on technological expertise in other parts of the UK or more globally through agreements that cover particular technologies or knowledge areas. Some have looked to parts of Asia and South America for partnerships. The North East Assembly has recently agreed a deal with Norway for additional oil supplies. This approach has led to some inequalities between regions in the UK but more specifically to differentiation, in terms of the energy mix, the knowledge base and the skills of each region.

With resource scarcity affecting parts of the UK in different ways, regions have generally had to develop their own solutions to meet their specific local or regional situation. Inevitably, tensions over water, in particular, have started to occur between the different regions of the UK. Exclusivity agreements for water between Scotland and the South East of England led to isolated riots in the hot summers of 2030 and 2031.

The links and interdependencies between water supply and electricity begin to surface in the general public's awareness. Highly tailored electricity flows have emerged at the regional level. Intelligent consumption and demand management are both introduced to ensure that the UK's natural resources meet the needs of the domestic population before international deals can be made. Recycling becomes 'a way of life' and an integrated part of the supply chain both commercially and residentially.

The energy mix differs somewhat by region in the UK as the federalist model strengthens, and stems from the various sustaining innovations that predominate in each area. For example, coal mines have been re-opened in Yorkshire (with coal sold both to other UK regions and abroad) and Nottinghamshire is set to follow suit. The regional assemblies insist on a stake in the new coal companies in order to maintain some control over the decision making. It's not without its problems, however, with opportunist open-cast mining uncovered in parts of both regions. This coal, and coal gasification, makes an important contribution to electricity generation. While there is awareness of technology standards across Europe and more widely, these are frequently adapted to fit the specific needs of a local environment.

Gas is used as a bargaining tool by many nations, forcing others to pay inflated prices to secure consistent supply. Dependency on nuclear power to provide a third of the UK's electricity caused considerable public debate – the UK government rejected the European nuclear model and decided to 'go it alone' with nuclear technology it felt was more reliable in order to benefit all regions of the UK. Fifteen years later and – eventually – the criticism has almost disappeared now that the technology has been seen to work and the new plants have reached their targets. The national government provided significant funding for infrastructure investment to the North West region in return for the region providing the main sites for the plants and the region is now reaping the rewards – it is at the forefront in terms of provision of green spaces for its citizens, retrofitted rental housing and efficient, sustainable tramways.

On the dock of the bay – 2050

Overall, most energy is produced from fossil sources and is expensive to clean up but fossil fuels have significant efficiencies compared to the past. The delicate nature of governance across the globe means that even with some bilateral agreements in place, there are power shortages several times a year when agreements are ignored or

supplanted by newer arrangements, or when systems simply breakdown. Some regions invest in fuel cells, batteries, spare generators and other technologies to help bridge outages as best they can.

With significant power, regional planning authorities rather than national or European Union directives have driven changes in the built environment. Inward investment has been made by many areas to try to create a more energy efficient built environment. Most regions have imposed smart metering in order to reduce consumption and the likelihood of blackouts. Scotland, Wales and the North East have all introduced taxes on wasteful energy consumption to fund energy improvements for poorer households and those living alone aged over 80, which has reduced social inequalities somewhat. But one of the most successful public campaigns has been the 'Wool is Warm' campaign run in Wales, which encouraged people to turn down their thermostats to save energy and wear an extra layer of clothes indoors.

One of the most notable changes in urban public space has been the profusion of trees. Although there is differentiation in regional regulation, green shade is everywhere, especially in public spaces, an extension of the trend towards tree planting which was seen at the beginning of the century. Water spaces are also valued because of their cooling effects, and cities such as Birmingham have made the most of its network of canals and basins. There are strict rules protecting green spaces against development in some regions, and even restrictions on people's ability to pave or patio their gardens (to mitigate against both flash flooding and heat effects). In some places green roofs are encouraged, although these tend to be the prerogative of particular developers, and their cost calculations on particular sites about water run-off and so on. There are some unintended consequences however – reducing the affect of the urban heat islands means that there is more demand for energy in winter. In addition, there is considerable conflict over the countryside, with pressure for development in the form of coal mines, quarries and intensive agriculture to produce regional resources.

The emphasis has generally been on retrofitting of existing commercial and residential buildings, using regional materials. Regional differentiation has increased, with particular regional or national styles much more identifiable than ever before. Indeed, when travelling between regions, one can often notice clear differences in aspects such as road surface, extent of suburban housing development, and type of streetlighting and so on. These contrasts are most in evidence in the towns closest to the English-Welsh border.

Some parts of the South West have implemented more radical planning schemes in order to accelerate the pace of retrofitting, in order that the region is more robust in the face of climate-induced weather changes. While it doesn't get involved in detailed planning debates, the national government has started to incentivise businesses to increase the pace of commercial retrofitting – with a recent advertising campaign which encourages every UK business to 'play their part' in ensuring the UK is self-reliant and robust for the future. Light emitting diode lighting and day lighting are integrated fully in most commercial buildings in support of this culture. There is an emerging practice among younger architects to make their buildings as adaptive as possible to change in use, so that they can be modified as needs change, rather than have to be demolished at far greater cost.

This is a world in which people value their own power and achievements – a television series celebrating 'Britain's inventors' has been a surprise success – and value continuity of trusted systems. In this world politics has a curiously old-fashioned feel to it, valuing

self-reliance, heritage, and security. Paradoxically, perhaps, leaders in the UK's regions and nations are playing exactly the same game, so the UK is closer to break-up than at any time since the Act of Union in 1707.

What it means to 'belong' to a region, though, has shifted over time. Most people are very comfortable with multiple identities – such as being Pakistani and Lancastrian. However, there have been some tensions in poorer performing regions, particularly where lower income groups have suffered disproportionately from climate-induced impacts and have required regional support as a result.

In the 3rd decade of the 21st century the UK remains predominantly a service sector based economy. However, for the first time in decades UK manufacturing as a proportion of the UK economy begins to grow. In 2050 the UK's Gross Domestic Product growth rate has decreased to 1.5 per cent having been around 2.5 per cent in previous decades. This hides a rather patchy overall picture of economic development across the regions.

Some regions have used their tax raising powers and chosen to invest heavily in sustaining innovations and infrastructure and skills to support them, while others have not. Climate migrants are welcomed when they have useful skills. Those parts of the country that prioritised saving energy have fewer power outages. Regional norms have started to emerge; for example in the North West central heating must be turned off by April 20 every year. Where there has been metropolitan investment, public transportation is effective and efficient. While government has sought to pressurise regions to prioritise investment, it has no powers to force their hand. Consumer pressure has generally been more effective.

It is a similar picture across different transport systems too – the regional assemblies insisted on regional dimensions to the franchises, thereby undermining cross-region public transport provision and causing pricing confusion for many customers. Those regions that made the decision to invest in their own energy supply have proven more robust than those that prioritised more experimental and disruptive innovations. The rail system built its own power plant during the 2020s and this has allowed rail usage to be reliable and to evolve broadly in line with demand.

Efficient public transport systems are a big draw for those people otherwise forced to pay high petrol prices and suffer on poor infrastructure in badly performing regions that chose to invest elsewhere. There are growing imbalances in demographic distribution across the UK as a result. Particularly, the past high population density of the South East of England is changing. Many people try to work locally and more flexibly in order to reduce their travel costs and wasted time.

London has seen some outflow of both businesses and residents due in part to the heatwaves that proved so unpleasant for people and costly for businesses. Effective trade deals for energy kept the city competitive and affordable for some until the 2030s, but it was forced to increase commercial rates and council tax substantially to meet energy agreements it made with the United Arab Emirates in the 2040s.

Brief timeline:

2013 Growing global instability over resource scarcity and rising commodity prices

2015 Welsh Parliament gains additional powers

2018 Coal mines re-open in Yorkshire

2024 Rail network builds its own power plant

2030 Isolated riots over regional water exclusivity agreements

UK manufacturing as a proportion of the UK economy begins to grow

2042 Energy agreement between London and the United Arab Emirates

Resourceful Regions – 2050

Sunshine State

How this world comes about: As fossil fuel supplies become scarcer and harder to secure, prices rise and energy is more widely used as a diplomatic bargaining tool. Many of the agreements which underpin the international economy start to fall apart. It's clear that fossil fuel – even coal – will be a declining resource, globally. The UK follows a path of improving its energy security, both by reducing demand and by increasing alternative supplies which it can control. Although securing energy supplies is the dominant concern in this world, decarbonisation remains an issue and the legal requirements of the Climate Change Act and of the 2016 Building Obligations, together with the Sustainable Communities Act, are powerful tools to help shape this world.

"Don't let what you can't do stop you from doing what you can do" has been the watchword since the UK economy, like that of other energy importers, juddered through the 2010s, a decade dominated by the realisation that oil production had peaked earlier than many had expected, by relatively high and fluctuating energy costs, by geo-political manoeuvring, and economic downturn. The experience for consumers in that difficult decade was of tighter incomes and less to spend, of power cuts, sometimes fuel shortages. At the same time, it proved to stimulate a surprisingly powerful shift in political and social philosophy, energising changes in local communities.

It was a world away from the 'live for the present' consumerism of the last part of the 20th century, and the shock has led to the emergence of new social values, which reinforce the importance of self-direction and self-determination, but also the need to try new ideas to resolve problems. Although there is technological innovation in this world, the principal driver of change is the development of new social institutions, many of which are about better ways of sharing limited resources at a local or community level. One of the motivations for this has been deteriorating mental health outcomes, worsened by climate change anxieties, which could have had huge public health costs if not addressed. Many of the new social institutions consider tackling mental health to be their priority, particularly in terms of the impact it has on the isolated and more vulnerable members of society who perhaps do not have strong family support structures in place.

This is a world where almost anything which can be decentralised has been. Transport has become more of a shared local community resource in many areas, with community-funded electric buses serving many areas. A significant number of private cars are also electric, whilst others run on locally produced hydrogen. These shifts have effectively resulted in large amounts of energy storage which can be used to balance the variable output from some renewable electricity technologies.

Constraints on energy production meant, certainly in the early years, that far greater emphasis was placed on reducing energy consumption. The reluctance of the existing utilities to move away from their market-based models meant that they were, effectively, brought back into social control through legislation, and the grid became a public resource. (There were diplomatic complaints from France and Germany, where some of the large companies were headquartered, and the government had a surge of popularity when it faced these down.) At the same time, regulation put the reduction of consumption at the heart of the utilities' public purpose, and clever framing of their governance promoted the development of multi-utility service companies (MUSCOs) at whatever scale could be made to work. Many towns took advantage

of this to take their utilities back into local management, sharing the savings from reduced consumption between the users and local community investment funds. In places where such incentives were not sufficient, the Minister's office had the power to implement rationing of energy, and water.

The economy continued to draw on the fossil fuels it had access to, including the rapidly declining North Sea oil and gas, and, where international agreements existed, imported oil (at a cost). Coal, likewise, is still used where long-term agreements have been honoured. Use of gas has diminished as price and availability have made it unviable, although in several communities there has been modest substitution of biogas as it was a good way to get fuel from waste. The life of the existing nuclear power stations was extended wherever possible, although the economic downturn meant that plans for new build were cancelled, amid scepticism which suggested that the industry was also over-claiming on its likely long-term energy production.

At first, local renewables and microgeneration did little to replace the declining fossil fuel base. From wind to solar to small tidal schemes, all were expensive and erratic. Investment was also difficult because many of the companies involved in the technologies were small, and there were skills shortages.

But as the technologies evolved, during the 2010s and the 2020s, costs came down rapidly, and performance improved. A huge gain came from the development of solar technologies which could be applied as films (eventually even through a paint-based application) which meant that the long-term promise of cheap (and local) solar power started to emerge during the '40s. It took some time to find effective ways to connect it to the local grid rather than it servicing only the building it was attached to. Local CHP plants also emerged in some places, especially where biomass could be grown as part of the fuel base. Other waste to energy options have also been pursued with some success – gasification, pyrolysis and anaerobic digestion. Some areas have developed biotech-based energy, although this was often unstable.

Edge of town – 2050

Related technologies also evolved at the same time, such as local pumps (to enable reuse of electricity which was generated and not used) and hydrogen fuel cells. New ways of thinking about power also helped. Virtual storage, helped by materials innovation, allowed the electricity supply industry to move away from its traditional model in which supply and demand always had to match.

Skills in the energy sector, however, were slow to develop. Some organisations resolved this by bilateral partnerships with European companies which had expertise already. The government also encouraged engineering and environmental sciences students by subsidising their education. The Transition Initiative movement, which had helped prime some communities with the skills needed to prosper in this world, also helped through its community-led Knowledge Exchange, the TIX. Organisations such as ICLEI – Local Governments for Sustainability, which linked local governments, also found a new prominence.

As with energy supply, a similar local emphasis is seen in the approach to reducing energy consumption in buildings. This, however, is supported by central government. Initially, this was a 'stimulus-to-aggregate-demand' scheme to mitigate the effect of recession on the UK economy. Home insulation, mostly, turned out to be relatively straightforward work, and people could be trained to do the basics quite quickly. In a world of energy shortage, paying unemployed people to work on insulation programmes made sense, and part of the cost was borne by the utilities, as one of the quickest ways for them to meet their energy reduction targets. Some of those working on home insulation have further developed their skills and become small businesses in their own right; they help people and places do 'resilience' adaptation. Increasingly over time, buildings were adapted so that they were better at coping with a hotter and wetter climate, as the technologies became better understood.

Smart metering helped, and behaviour change for reduced energy consumption was reinforced by meters with highly visible consumption displays – in kitchens and living rooms, rather than at the end of the hall. Some local authorities issued the so-called 'Swedish lamps' which adapted to more pleasing shapes as the user reduced their consumption, which seemed to be a more effective visual guide for many than a graph or a numeric display.

Some houses and commercial buildings, from the 1950s and '60s, were so poorly constructed that they were too expensive to upgrade, even through quite complex insulation schemes, and much of this stock proved to be in the public or social ownership. Following the introduction of the 2016 Building Obligations Act in some areas these buildings were simply knocked down. In others, where UK cities had partnerships with European cities which had better developed building expertise, it was rebuilt using techniques such as offsite construction. Some of this aged better than others, and even by 2050 it was becoming clear which authorities had rushed into their investments, and which building systems had proved to be more robust.

Successive Energy Regulation Acts (ERAs) had required local authorities to assess local planning decisions in terms of their energy impact on the local area, and this has influenced the shape of the built environment over time. Local shopping streets have returned, as fewer people want to waste fuel for short journeys. Those edge of town supermarket sites which are still in the hands of the grocery companies have long been converted to local storage and distribution centres or other uses. Another dramatic effect has been the end of the school run, as schools gained the legal right to decline pupils who could not make their own way to school either by walking, cycling or public transport.

One of the decisive developments occurred when Bradford Council took the Competition Commission to court over a decision which threatened to undermine its local Energy Reduction Strategy (ERS), and the High Court ruled that the Commission's ruling had lower legal standing than the ERS. Following the resignation of the Chief Executive of the Commission, her replacement announced quickly that future Competition assessments would require full external and lifetime costs to be taken into account.

One of the biggest differences has been in greening the local environment, particularly to create more sustainable urban drainage systems. Green roofs are widely installed, and not just on new buildings, which helps both to absorb heat and also mitigates flash flooding. Generally there is more tree cover. 'Soft flood systems' are preferred to 'hard defences'; large areas have been re-designated as 'water meadows' to catch and hold river flooding. The government supported this with a compensation fund for those who found their houses on the designated areas, and were therefore all but valueless overnight.

The emphasis on devolved responsibility meant that communities often felt that they had the power to act effectively, but it also meant that some were more effective than others. If there is polarisation in this world, it is a spatial polarisation, in which areas with effective leadership and substantial local social capital tend to do better than others. Initially the role of government was to intervene when disparities became too acute. Eventually these were resolved by changing the rules. Regional conflicts were reduced by creating new 'bio-regions', aligning administrative and political power with resources. This introduced a new form of bio-governance effectively into Britain and supported the afforestation programmes established as offsetting initiatives. The Sustainable Regions Act, in 2034, laid out the groundrules for collaboration and conflict resolution.

This is not a world of significant economic growth. Growth stalled during the 2010s, and the cost of energy means that the economy is not dynamic. But this is true everywhere and, increasingly, economic theorists are arguing that the sustained growth of the 19th and 20th century was down largely to falling energy costs rather than knowledge. It is possible to 'decouple' energy from the economy, but not completely. The numbers are hard to find, but statisticians constructing Gross Domestic Product time series data reckon that after a period of declining incomes in the 2010s, 'Gross Domestic Product growth' was around 0.25-0.5 per cent per year, if that. But as advocates point, a 'steady state economy' is not the same as a low-to-zero growth economy. It's a different mind set.

The shift in values in this world means that economic growth rates are no longer the main yardstick by which a society's success is measured. People are more likely to know their neighbours, car pool for journeys and they are more likely to eat more healthily; there is less energy intensive food production. Local currency schemes and time banks emerged during the recession and are now flourishing across many regions – making Gross Domestic Product quite an unreliable guide to social and economic activity nowadays. In the UK, the government has instituted a new 'Measure of Domestic Progress', sometimes known as the 'sunshine index' based on the earlier work of William Nordhaus, James Tobin, and Herman Daly in calculating sustainable economic welfare. However, it proved difficult to provide measures for supporting the lowest income groups in the absence of economic growth and this led to some social tensions.

Expectations have shifted from the turn of the century, this world is slower and it is different, but it is still an affluent world by any historical standards.

Brief timeline:

2012-16	Emphasis on reducing energy consumption
2016	Building Obligations Act
2019	Bilateral skills agreements between some UK energy sector organisations and European countries
2021	Last edge of town supermarket built
2032	3rd Energy Regulations Act
2034	Sustainable Regions Act
2041-44	Cheap and local solar power emerges
2044-45	Local pumps and hydrogen fuel cells in wider use

Sunshine State – 2050

Green Growth

How this world comes about: Increasing energy costs, driven by rising demand and shrinking supplies of fossil-based fuel, and the translation of concern over climate change into effective action to reduce emissions, has led to radical action to move to a 'new energy economy', and also to use technology effectively to reduce both energy losses and emissions from buildings and travel. This radical transition requires significant investment in technology, and international collaboration. This is a world of a 'green boom' – but it is not without its risks.

The long recession of the 2010s, in Europe and elsewhere, led to the realisation that the age of cheap and easy energy was now over. The outcome was a radical restructuring of the economy to de-couple economic performance from energy consumption, informed by a shift in underlying social values which emphasised universalism and benevolence as against the more individualist values which had underpinned the globalisation boom of the last quarter of the 20th century. These values also supported the increased urgency around dealing with climate change, with strong commitments on carbon reduction reinforced by international agreements; the energy agenda and the carbon agenda became mutually reinforcing.

Although high prices for essential resources meant that the market started to respond to the energy transition, the speed of change desired by politicians – and by voters – was greater than the market would have delivered on its own. The UK, in common with much of the European Union, has adopted a mixed approach.

In energy, a strong tax-led approach – based on carbon impact – has pushed up the price of fossil fuels, despite hostile campaigns from the road freight industry, intense private lobbying from the oil industry and open grumbling from the energy utilities. This approach has succeeded because – based on the earlier model of London's congestion charge – the tax revenues raised have gone directly to funding investment and development of large scale renewables. Tax reductions could be achieved through the purchase of carbon offsets.

For this is a world in which big is still regarded as essential. The calculations done by economists and engineers at the UK's Department of Carbon, Climate Change and Energy reckon that small scale decentralised renewable energy systems simply can't deliver the amount of energy required by a modern economy. But at the same time, policy makers have also pushed nuclear out of the mix, except as a transitional technology, because the amount of investment a nuclear programme requires would squeeze out investment in large scale renewables. One thing that was saved, though, is the research funding into nuclear fusion. This is regarded as a technology with potentially huge energy rewards, because, in general, engineers are optimistic that the technological difficulties will be overcome.

In some areas of the economy, regulation drove reduction in demand for energy; in others, public procurement has been the chosen policy vehicle, as we'll see shortly.

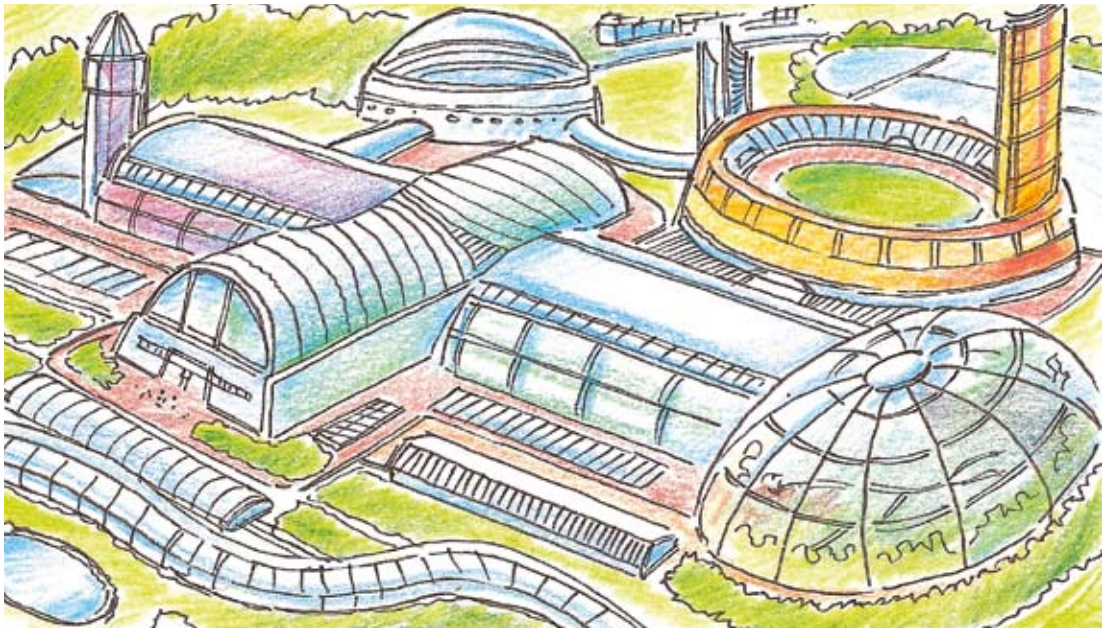
By 2050, the majority of the UK's energy is coming from renewable sources, though not necessarily from within the UK. Certainly, the tidal barrage across the Severn was built, and successfully, at least in terms of energy production. (Some of the biodiversity impacts have been as bad as environmentalists feared.) Hydroelectric power comes from the Pyrenees and there are significant banks of windfarms sitting offshore, more extensive, and with larger turbines, than their onshore predecessors. And a reasonable

proportion of the UK's energy has recently started to come from the solar arrays in southern Iberia and the northern Sahara, even if the technical transmission difficulties have not been fully resolved.

Against this background, there has been some development of local power systems, although these fail to compete on price with large-scale renewables. However, because the grid is still slightly unstable – an inevitable feature of the intermittent power supply, and because large-scale storage technologies are still developing as materials evolve – businesses and communities often invest in local energy production, sometimes linked to their waste management systems, to help manage power outages.

Supply fluctuations are also managed through smart power systems. It's rare, at least in winter, for washing machines to operate at peak times, even if people are still frustrated to find lights or music systems being switched off by the grid.

Individuals have 'energy avatars'[9] which are fully automated and provide information on energy usage. These have helped change people's attitudes and consequent behaviour. While many people were originally motivated by the financial savings, they have now started to change their fundamental values and find being part of such a social movement rewarding and motivating.



Green Growth – 2050

With both energy and carbon management central to public policy, addressing the energy consumption of the transport and domestic sectors became more important. Transport proved responsive to variable road-pricing, which accelerated the development of lower emission and electric vehicles while also reducing personal car use. Car clubs, with a 'pay as you go' proposition, developed quite quickly. Effective communications technologies reduced the need to travel for business, and their manufacturers responded to carbon taxes by developing far more efficient products. In general, regulation on closed loop production systems has nudged the corporate laggards into line; market leaders had long seen the benefits of this whole-system approach. There has also been strong growth in virtual meetings; the use of virtual

9 An energy avatar is an electronic, usually graphics-based, version of the user. In the context of energy, avatars could be used within households to provide immediate and interactive information about energy service and suggestions on how to reduce consumption.

environments for business discussions may have seemed self-conscious in 2008, but it was straightforward by 2050. Such developments, however, were not completely straightforward; power consumption of computer server farms had spiralled in the 2010s until aggressive energy management and innovation approaches brought it down again. One of the biggest changes in domestic energy was the introduction of parallel 12-volt electrical systems within houses, although this large infrastructure project turned out to be every bit as complex as sceptics had foretold.

The impact on the construction industry was intense, and the pace of reform in a sector which had often been regarded as old-fashioned and inward-looking was intensified by regulations which required a full-service approach both to construction and management of new buildings, in which the developer was required to take responsibility for maintenance and service once the building was completed.

In housing, the average age of the UK's housing stock, coupled with its vast inefficiency, proved to be an opportunity to 'skip a generation' and move to a new approach to construction. The Welsh Assembly was a pioneer, issuing a contract in 2017 for the demolition of a large 'low-demand' estate in the Rhondda Valley and its replacement by a new generation of zero-emission housing. These homes were built cost-effectively using modular designs developed in Sweden and off-site construction techniques. Their underfloor electric heating systems were popular with the residents. This was one of the first projects to require that the new development was managed by the developer. The UK construction industry proved unequal to this challenge at first, because of its traditional attitudes and a shortage of skills, and German and Scandinavian companies repeatedly won such early contracts.

In East Anglia and the Wash, innovations included the development of floating districts, which sat on the saltmarshes which had encroached on the coast.

In other parts of the country, 'Eco-Zones' (based on the old Enterprise Zones) gave tax breaks to developments which were carbon-positive, and since these were built during the 'transition' years when fossil fuels provided a significant part of the energy mix, these often included local wind turbines and community Combined Heat and Power schemes. By 2050, the turbines seemed to date these developments. However, useful lessons had been learnt from these developments even though they were now branded as failures.

Some of these schemes might never have got through the old planning system. But the development of the 'Strategic Planning Framework' has given governments powers to impose large-scale developments on local areas, if they consider it necessary in the national interest. It is repeatedly a source of local complaint.

The emphasis on new build and smart management of energy systems means that there is less emphasis on 'retrofitting' of existing houses, and houses with high energy and carbon consumption become less valuable. (High carbon consumption is seen a sign of personal and social failure, and ostentatious plane travel is regarded with the same disdain as the conspicuous consumption of red meat.) Older stock on the outskirts of towns and cities are particularly down-valued, because of the cost of transport; convenient and well-connected locations are much more desirable. Housing stock from the 1980s – once sold as 'executive homes' – but now requiring an energy-intensive lifestyle, have become the new slums. Rehousing schemes are mooted.

By contrast, the higher density flats that were being built in such large numbers in the 2000s have undergone mixed fortunes. There proved unpopular during the 2010s and 2020s, when demographic change meant that the main demand was from family units. Prices fell. But by the 2050s, households including families were learning to live in different ways and their location close to urban facilities were making them desirable again.

In commercial buildings, one of the most radical changes was the banning of air conditioning systems from 2031 (the legislation had been passed in 2021, to give building managers time to adapt.) The rationale was two-fold – as temperatures grew warmer, the energy consumption of air conditioning systems started to be a significant issue in a world where renewables were still coming on stream. But secondly, as 'heat island' effects became increasingly pronounced, there were important social equity and public health arguments – buildings shouldn't just dump their excess heat into their surroundings. (After all, the argument went, they weren't allowed to do that with noise or waste). The most radical effects were on shopping centre and supermarket management and design. Public health became a concern after the deaths of several thousand elderly individuals in London and Birmingham due to the night time heat one summer.

As always, shifts in public policy took time to translate into the education and training systems. It was only when UK companies repeatedly failed to win housing development contracts that the government and the industry took it seriously, but it wasn't until the late 2030s that this had an effect, at least in the existing construction sector. Fortunately, the UK's engineering sector proved to be surprisingly robust, and many of the new building systems fitted better with their expertise and business models. Most of the newly skilled in the housing sector had an accreditation via the Engineering Employers' Federation (EEF). Most of the companies which adopted new techniques, and were most innovative in using the so-called docile and aggressive materials, turned out to be led by graduates from these EEF schemes, and in 2040, the Federation renamed itself the Engineering and Building Employers Federation.

A similar shift is seen in the energy sector, where traditional companies failed to adapt to new technologies and new systems. Big winners here included the IT service businesses, whose expertise lay in connecting complex systems and managing them on a service basis for their clients.

Although the economy has grown steadily, at least after the recession of the early decades of the 21st Century, at around 2 per cent per year, the balance is different from the late 20th century. The reconstruction of the energy and housing sectors has required a huge level of investment, with a concomitant increase in both taxes and savings levels. Growth, therefore, is investment-led. There is less spending on consumption. But this is tolerated because people don't believe that there is an alternative, and because the sense of technical progress, and optimism, is palpable.

Although there are people who are disenfranchised – as there always are in technology-driven societies – politicians have been shrewd enough to realise that if these people are not helped it could challenge the credibility of the whole 'transition' project, so social safety nets are in place, often involving retraining for the skills needed by the new economy.

And there are always new challenges. By 2058, it looks as if biotech has finally succeeded in creating a fuel which can power vehicles effectively. And a pilot scheme for a local hydrogen energy scheme has just been unveiled in Sheffield, paid for by central government. If it works, it could be the start of something big.

Brief timeline:

2017 Proposed demolition of some 'Low-demand' estates with replacement by a new generation of zero-emission housing built to Swedish model

2019 Tax system based on carbon impact, with scope for tax reduction through purchase of carbon offsets.

2022 First electricity generated by the River Severn tidal barrage

2033 Legislation to prevent 'Heat dumping' from buildings is introduced

2040 Successful transmission of electricity from Iberian solar array farm

Green Growth – 2050

Carbon Creativity

How this world comes about: By 2020, China and India are dominant global economic players. Because of their impressive economic performance, however, rising energy costs and pressure on raw materials starts to have a significant effect on the BRIC (Brazil, Russia, India and China) countries' growth rates by the late 2010s – and, in an inter-related economy, on material living conditions elsewhere. Global energy management becomes closely linked with climate change and carbon reduction and, in the absence of significant breakthroughs in new energy sources, the focus is on working together to manage existing resources better.

This is an outward-looking world in which free movement of capital and goods are still regarded by political and economic elites as the ideal model for economic development. However, competition for natural resources and declining economic growth rates prompted the rise of populist calls for protectionism in many countries.

In the UK, the stable economy that was so well supported by the service sector begins to slow down reflecting an average change in Gross Domestic Product growth rate from 2.75 per cent to 1.75 per cent in 2050. UK and other European countries continue to enjoy per capita income levels that are among the highest in the world, although the more rapid growth of the BRIC countries means that Europe's output as a *proportion* of total global economic output has fallen.

Perhaps the most popular policy response to greater resource stress is a stronger focus on free trade blocs. Alongside the European Union and NAFTA, there has been growth in the influence of organisations such as MERCOSUR in South America, ASEAN in South Asia and the African Union. This renewed focus has had two broad effects on energy and sustainability policy. Firstly, there has been greater focus on multi-national agreements, which are primarily negotiated and agreed between blocs, committing participants to reducing emissions (primarily through a robust carbon market). Secondly, blocs are increasingly making use of their combined strengths to negotiate multinational agreements – not least of which are long term energy supply contracts in an attempt to guarantee supplies in future. Moreover, these supply contracts do not deal simply in oil and gas, but also in the supply of electricity – facilitated through further development of an international electricity grid.

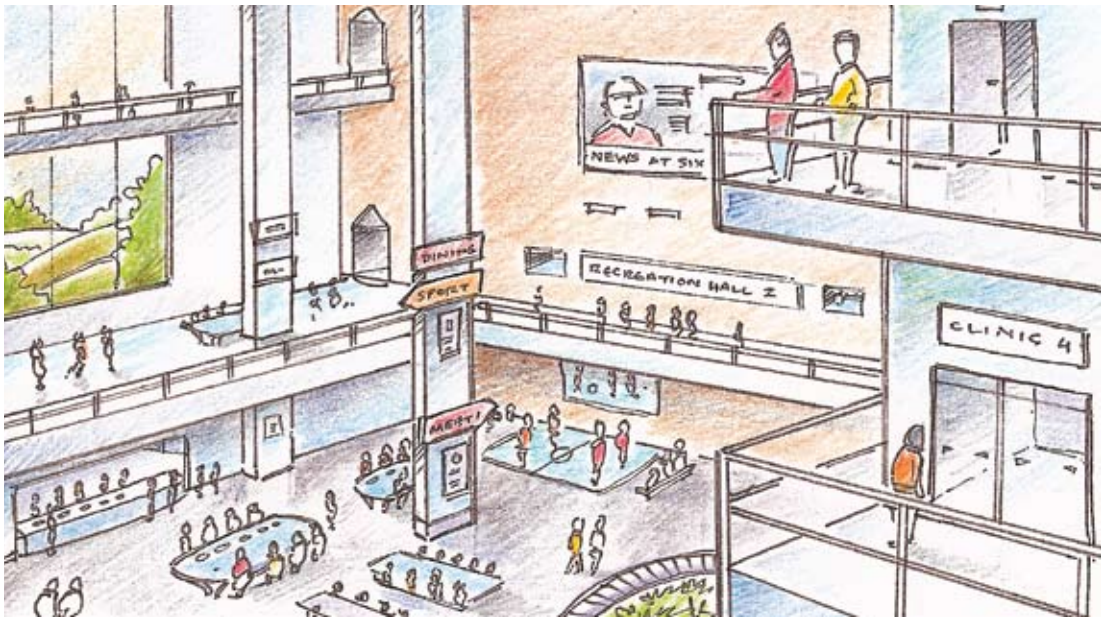
Despite this renewed focus on transnational co-operation, however, there have not been any substantive new international institutions for dealing with global problems. Institutional inertia plus a resistance on the part of incumbents to share their veto position have proven significant barriers to a new international architecture.

London, capitalising on its historical strength and skills in international trade, has emerged as the global centre for carbon trading – which by 2025 has developed into the world's biggest commodity market. This well-established market also has a direct and visible impact on consumer behaviour. The carbon market ensures that the carbon price of each product is embedded in its cost. The UK's manufacturing industry has not been able to respond to the demand for low carbon goods and therefore products are imported. Alongside the carbon market itself, a thriving service sector industry in carbon reduction consultancy has emerged, with consultants advising businesses and householders on the best way to reduce their carbon bills.

The introduction of this market has made a significant impact on behaviour, making the level of carbon emissions a much more pertinent issue when deciding which products and services to purchase. It is still a society driven by consumerism, but energy demand management becomes a big feature of everyday life. In part this is driven by the cost of carbon-based fuel, but it is also because energy supply, generally, remains tight. It's expensive to drive so pressure on public transport systems has increased although innovation investment in it has not kept pace. In areas with high density developments near public transport nodes, the need to travel has declined. New sources of decarbonised power are slow to come through, so prices of this power also remain high. In this world, cost saving is still considered a very attractive reason for reducing energy consumption, both for individuals and for commerce – energy as a proportion of income expenditure has grown. This concern, combined with the economic slowdown in the early decades of the 21st Century, produced a reduction in CO2 emissions from wealthier economies, as they move towards a period of reduced household consumption and prudence.

Social values have shifted over this period – continuity of systems is cherished and while there is a desire for security, there is also a need for universalism. Consumers are having to adapt to a world with choice constrained by carbon considerations. Some consumers are finding it difficult to adapt.

Extreme weather contingency planning has become critical in order to deal with infrastructure damage in a more cost effective way. Ongoing maintenance has also become more important in order that areas are not so vulnerable to the impact of summer and winter extremes – such as buckled roads during three successive hot summers. In addition, 'hard engineering' approaches to the more frequent flooding – such as higher walls, bigger pipes – are being used, with concrete and other materials being produced with a lower carbon impact than in the past.



The clinic by the park – 2050

Much energy in this world is still generated from the incremental development of conventional sources – coal, gas and oil. Centralised generation remains important. However, price volatility and rising cost of carbon emissions (driven by the carbon market) provide an increasing incentive to invest in proven technologies such as large scale Combined Heat and Power plants and coal with Carbon Capture and Storage. One side effect of the spread of carbon capture and storage technology has been the

re-emergence of 'King Coal'. Countries (including the UK) with accessible coal reserves have seen the rejuvenation of their mining industries, as fuel which was previously too expensive and dirty in terms of carbon emissions becomes economically and ecologically viable again. Centralised carbon capture and storage facilities are attached to all large power stations with storage on site or remotely transported via the 'carbon' grid, which is a network of pressurised pipes.

Within Europe, the European Union started to promote the nuclear option much more vigorously as a way of encouraging supply security. While the economics, safety, and carbon costs of nuclear generation are still fiercely contested (and the cost of securely storing nuclear waste is still high), the relatively stable price of fuel and security of supply make this an increasingly popular option. Although the UK had a shortage of nuclear engineers to work on replacing its 20th century capacity, it was able to utilise the skills of other European Union nations in this area to ensure it could benefit from such developments.

UK energy generation and distribution is supported through the UK's membership of the European Union Gas and Electricity Regulation Organisation (EUGERO). This regulatory body was set up in 2025 to distribute electricity and gas. Its establishment reflected, in part, the concern of a number of European countries for the need to share resources and restrict the growth of small scale production. The focus of the EUGERO is very much on decarbonising energy, but it has also sought to protect the carbon poor by regulating energy utilities to prevent the exclusion of the poor from the market or the creation of energy 'deserts' with poor supply.

Large scale building infrastructure work is still commissioned through public-private partnership arrangements to support the ageing infrastructure. Retrofitting of novel insulation and other energy efficiency measures to the existing housing stock has been incentivised strongly by regulation and the economic reality of a good payback. Ease of installation, with low impact on property design, has been the key to success and the small business sector has developed to deliver these effectively; this was after early rogue traders were cracked down on for their faulty workmanship. There are some services which seem impervious to scale; some of these businesses would have been installing satellite dishes seventy years ago.

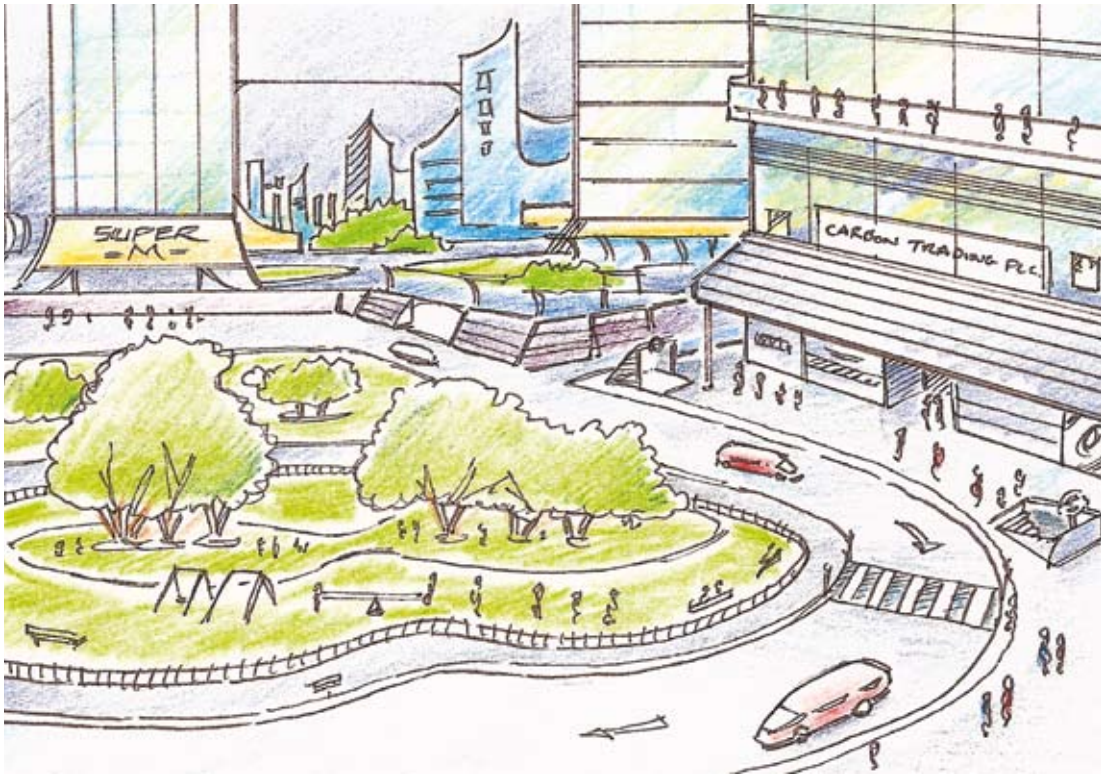
There are also some new developments for planning and housing under the permissive planning system that evolved during the 2040s. The targets and initiatives of 2006-16, e.g. zero carbon homes, along with impetus from the carbon market, have led to high density mixed-use (residential and commercial) developments. These have received some bad press, particularly from the older population who enjoyed the space that lower density developments of 30 years ago afforded. In contrast, the younger generation and the local planners are enthusiastic about these areas as they offer flexibility and a community environment – in their minds they are the mid 21st century equivalent of the loft conversions so trendy and coveted in the late 20th century.

The design and build of these units reflects the growing knowledge of how to mitigate and adapt to climate change. These mixed use areas incorporate green spaces, photovoltaics on some roofs (but not connected to the grid), solar panels and natural ventilation systems and are, therefore, cooler and better adapted to the changing environmental conditions. Groundwater is also used widely to cool buildings. Combined with the now widespread European Union knowledge of improved efficiency heat pumps, advanced glazing etc., these developments look to tick all the low carbon boxes. Indeed there has been significant payback from retrofitting – costs have gone down

because the market has expanded and economies of scale have been taken advantage of. To meet the requirement for installing and maintaining these technologies, apprenticeship opportunities and higher education courses in these areas have sprung up and student registration has been high due to the high demand and decent margins. Most large organisations sign up to the European Union Investment in Carbon Champions Programme to further improve skills and knowledge sharing across the continent; there is now a well established set of environmental and design tools for building performance. Curriculum Vitae include lifetime personal and professional carbon use.

Brief timeline:

2013-18	3 Multi-lateral agreements on reducing emissions (through carbon markets)
2021	European Union promotes nuclear power to encourage security of supply
2025	Carbon trading is the world's biggest commodity market; London is the centre for trading
	European Union Gas and Electricity Regulation Organisation set up
2033	Regulatory incentives to encourage retrofitting of residential and commercial buildings
2042	High density mixed use developments common



Carbon Creativity – 2050

Appendix C: Working with scenarios: some underlying principles

Working with scenarios should be a rewarding experience which allows an organisation to address complex future questions and issues that may otherwise seem hard to resolve. Scenario narratives represent a view point, or more usually a set of diverse viewpoints on what could happen in the future, rather than factual accounts of what is happening today. It is therefore important to be aware that using scenarios can represent a challenge, albeit a stimulating one, to 'traditional' modes of thinking and ways of working.

There are a number of key principles and points to be aware of before engaging with and working with the scenarios in more depth.

- Before you start it is important to define the scope of the issues you are trying to use the scenarios to investigate, in order to allow you to tailor the process and scenario material accordingly. For example – if your particular interest is the sustainable energy management, is it the entire energy management system that you are interested in, or are you interested in focussing on a particular area?
- Don't question/doubt the basis of the scenarios themselves. Remember that scenarios and futures work is about what might happen if the scenario came about, not whether the scenario itself is right or wrong.
- Focus on thinking about what would happen in the scenario given the set of circumstances and events described, rather than questioning whether the scenario would happen at all.
- Immerse yourself in the scenarios first, and make sure you have at least a basic understand of them all before making judgements about what it means for future policy/strategy.
  - (Tip – to assist with this immersion it's often useful to consider the kind of headlines and stories that would be reported in news bulletins (presuming they exist in some form by 2050!) or in the press, to get a real feeling of the scenario)
- Don't do it on your own – involve others in any work involving scenarios. The more diverse the range of people involved – the richer the discussion will be. For these reasons we recommend working sessions and workshops to make the best use of scenarios.
- Don't be afraid to give it a go. Working with scenarios is an iterative process, which requires the use of lateral thinking and tacit as well as explicit knowledge.
- Don't worry if you feel unsure or uncomfortable about what you are thinking and/or doing during any particular stage. The scenarios are meant to stretch the thinking of organisations and individuals, capturing as they do some events and circumstances that are at the edge of likely possibilities.
- It is OK (some would say natural!) to feel uncertain when working with scenarios, so feel free to use a combination of head and heart when thinking about them. Work in small teams or groups to sense check your thinking with others.

Making use of scenarios to inform future strategy and policy development

One of the comments people make about scenarios is that they often remain as interesting stories about the future, because people find it hard to apply them to specific policymaking challenges.

Scenarios should not be used in isolation, but used alongside and in conjunction with other analytical tools and processes when tackling policy. For example scenarios can be used as a first step in the development of strategy by building a shared vision. Other tools can then be used to develop the detailed implementation of that strategy. At the other end of the spectrum, scenarios can be used to run a final "future proofing" check on detailed policy recommendations or other decisions that have been developed through other policy making processes.

In all cases scenarios can enhance and enrich the analysis of high level strategy and more detailed policy recommendations, to ensure that the final output is more forward looking and future facing.

Broadly speaking, scenarios can be used in three specific ways:

- To develop or refresh corporate vision and high level strategy or inform the development of future strategy and related priorities for a specific policy area, function, or region of the country;
- To assess the strengths and weaknesses of different policy options (the 'Windtunnelling' option outlined in Chapter 6);
- To future proof existing plans, actions or decisions that are on the table, or provide a health check on current strategy ('future proofing').

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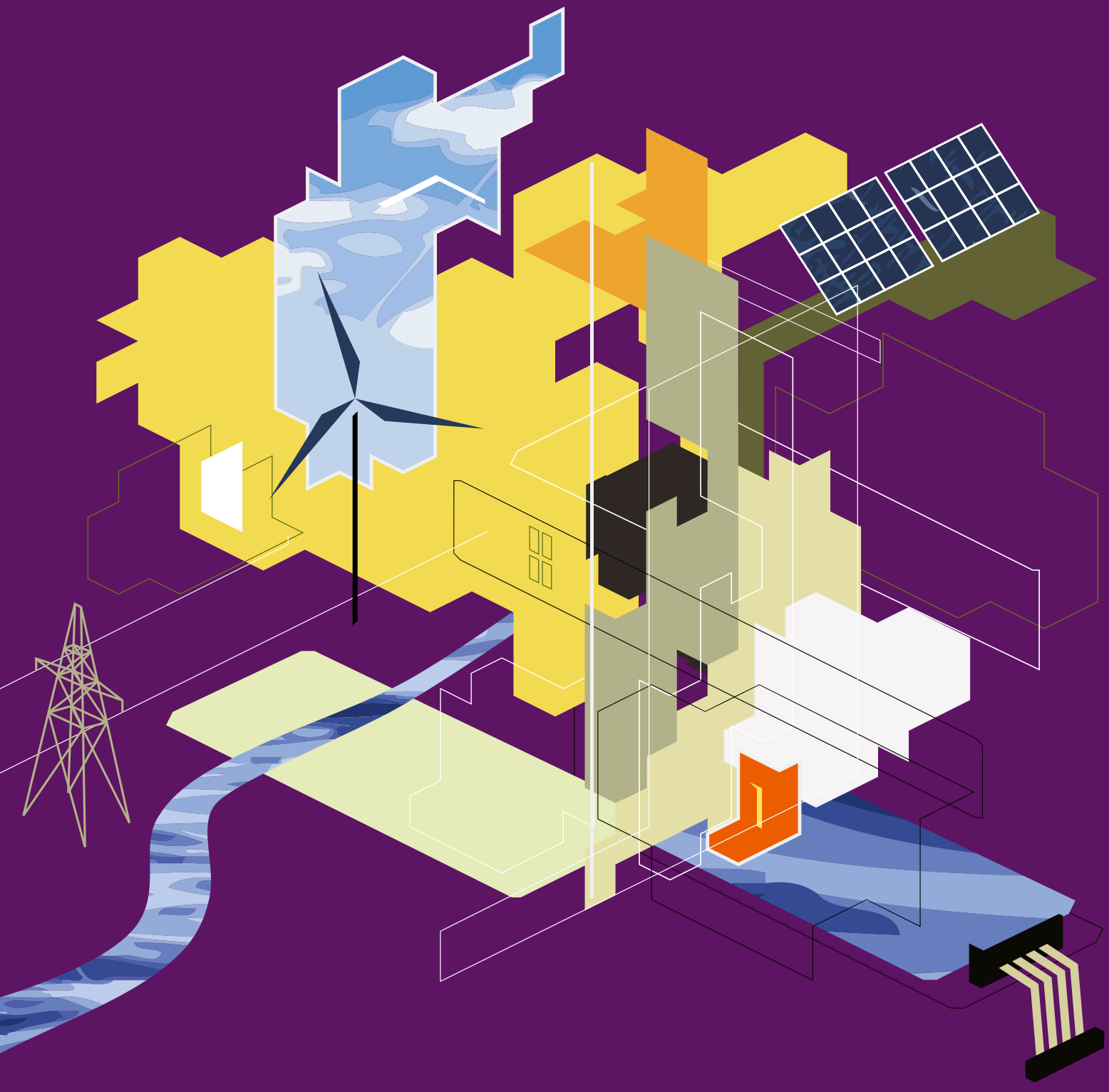

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